

11 can only be removed by pulling it with a force exceeding a certain threshold. The light delivery arm **1183** contains an array of sources of radiation **1184** to excite the fluorescent target-linker-label conjugates that may have become bound at each of the sensor pads **45** during an assay. These sources of radiation may include, for example, compact semiconductor lasers or light emitting diodes with wavelengths of emission that are appropriate for excitation of the fluorescent dyes. One skilled in the art can recognise that a plurality of beam shaping and conditioning optical components, including, for example, optical diffusers, integrated lenses and apertures may be included in the light delivery arm **1183** to achieve homogenous illumination of one or more rows of sensor pads **45**. The sensing arm **1185** contains light collecting optics **1186**, which could, for example, comprise of a lens and/or pinhole array arrangement, an optical filter **1187**, and light detecting elements, which could include photodiodes, photo integrated circuits, phototransistors, photomultipliers, charge coupled devices or CMOS detectors. In various embodiments, the light detecting elements are selected and arranged in the sensing arm **1185** so as to be able read the assay status at each of the sensor pads **45**.

[0133] In various embodiments, the light delivery arms **1183** are arranged so as to be fixed at an angle 45 degrees with respect to the normal to the surface of a fluidic chip **26** inside a cartridge **11** that has been inserted into the mechanical assembly **1182**. Alternative configurations can be implemented using different angles. In these various embodiments, the amount of excitation light that may pass into the sensing arm **1185** is reduced. In other embodiments, two light delivery arms **1183** with a 90 degree angle between their optical axes may be employed to excite two parallel rows of sensor pads **45** within a fluidic chip **26**. Alternative configurations can be implemented using different angles between the two light delivery arms **1183**. In another embodiment, the sources of radiation **1184** are mounted into the light delivery arms **1183** using chip-on-board technology, an optical element is included in the delivery arm **1183** to collect, collimate and direct the light used to excite the fluorescent target-linker-label conjugates.

[0134] In various embodiments, fluorescent dyes are chosen with excitation wavelengths in the range of 620 nm to 650 nm, allowing inexpensive light emitting diodes can be used as the excitation sources **1184**. These photophysical characteristics may lead to certain advantages for fluorescent immunoassays. Firstly, these excitation wavelengths are not absorbed by physiological fluids such as blood, serum, sweat, urine and: saliva. As a result, energy from the excitation source is not lost. Second, as the emission wavelength is Stokes shifted from the absorption wavelength, the fluorescence signal is not blocked by the optical filter **1187**. Another possible advantage of this approach are the reduced background contributions to the fluorescence signal, due either to the materials employed for fabrication of the fluidic chip **26** or the sensor pads **45**, the reagents that may be employed during the assays or other adventitious contaminants and impurities that may be present in oral fluid samples.

[0135] Referring to FIG. 12, in various embodiments, to detect the fluorescence signals that arise following excitation of dyes in conjugates that have become bound at each of the sensor pads **45** during an assay, one photo integrated circuit **1291** is provided in the sensing arm **1185** for each sensor pad **45** in the fluidic chip **26**. In various embodiments, this approach facilitates detection of the relevant fluorescence

signals in parallel and, for example, no mechanical scanning of the sensor pads **45** across the sensing arm **1185** is required. The absence of moving parts in the reader **13** is an aid to maintaining optical alignment, increasing robustness and reducing manufacturing costs. In various embodiments, if a typical, commercially available light emitting diode is employed as the source of radiation **1184**, and the label-linker-conjugates described previously are employed as the fluorescent reporter, the magnitude of the optical signal that may be detected at each sensor pad **45**, under standard assay conditions for drugs of abuse with typical detection thresholds in the range of 10 to 100 ng/mL, can be greater than 100 pW of optical power. As a result, to collect and collimate the emitted fluorescence, an array of pinholes **1292** can be placed in the sensing arm **1185**, in the optical path between the sensor pad **45** and the detecting element **1291**, along with a filter **1187** to prevent any unwanted radiation from the light emitting diode **1184** reaching the detecting element **1291**. Since pinholes are easier to align and less costly than lenses, this feature can further reduce manufacturing costs in various embodiments, while still providing the detection sensitivity necessary to carry out fluorescence-based assays for drugs of abuse. In another embodiment, fluorescence signal is collected by a light guide, for example a fibre-optic connection, and directed through the optical filter **1187** onto the detecting element **1291**.

[0136] Referring to FIG. 13, a cartridge **11** may be equipped with guiding rails **37** that facilitate its insertion into the reader **13** and provide a first order of alignment between the reader **13** and the sensor pads **45** within the channels **42** of the fluidic chip **26**. To provide more accurate alignment between the reader **13** and the sensor pads **45**, the reader **13** may also be equipped with alignment parts **1301** which interact with features of the cartridge **11** by direct contact in order to ensure correct registration. In various embodiments, there is a chip location dowel **1302** which interacts with a feature **39/48** on the edge of the fluidic chip **26** within the cartridge **11** to ensure alignment of the chip with respect to the x direction. With commonly used methods of fabrication, an alignment tolerance of about 0.12 mm can be achieved. There is also a datum feature **1303** that interacts with the base of the chip to align it with respect to the y direction, again to a tolerance of 0.12 mm. Finally, there is a datum face **1304** against which the front **21** of the cartridge **11** is pressed to align it with respect to the z direction to a tolerance of about 0.1 mm. This approach thereby enables direct registration between the sensor pads **45** located within the channels **42** of the fluidic chip **26** and the optical elements within the reader **13**. To ensure robust retention of registration, pressure may be applied to each of the alignment features by spring loaded bars **1305**. As a result, in situations in which the analysis system **10** is used in non-laboratory environments, whereby it may be subjected to externally generated mechanical shocks, these tolerances are maintained in the event of a mechanical shock.

[0137] Referring to FIG. 14, in various embodiments, the reader **13** is manufactured using external mechanical shielding **1401** in addition to electronic design practises that are known to confer resistance to environments containing high electric fields **1402**. This enables the module **13** to operate in an error-free state in environments containing stray electric fields, or other high electric fields, such as those associated with professional mobile radio systems such as Terrestrial Trunked Radio (TETRA).