Bruker SPR #64 – Details on Hardware

High throughput, robust design, no compromise.

Abstract

Bruker's new SPR #64 combines simple microfluidic design with robust hardware to achieve maximized throughput and outstanding performance. Its hardware features are described in the following technical note.

Keywords:
Bruker SPR #64,
high throughput,
high sensitivity,
application rich

Introduction

The SPR #64 is Bruker's first surface plasmon resonance (SPR) system that enables read-out of 64 interactions on a single SPR sensor chip. The microfluidic manifold consists of a simple 8-channel design which can be rotated by 90 degrees leading to an 8x8 array. In addition to the 64 sensor spots, a total of 144 interspots can be recorded and used as a physical reference. An overview of the spot array is shown in Figure 1.

Authors: Sven Malik, Cyrill Brunner, Paul Ritter, Christopher Pelczar, Soumav Nath; Bruker Daltonics GmbH & Co. KG, Bremen, Germany.

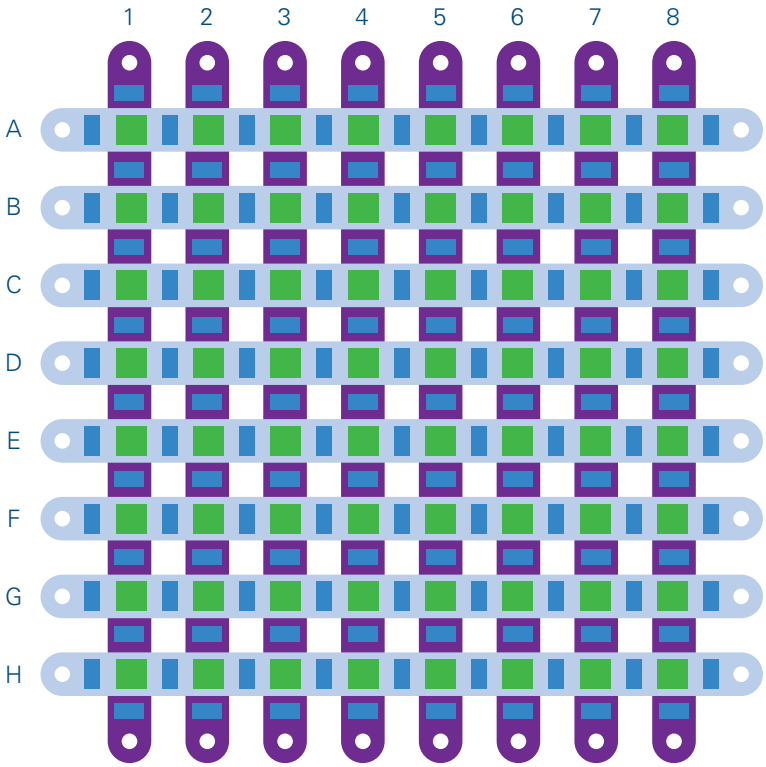

Figure 1
Spot array of Bruker's SPR #64. Green: sensor spots, read-out of interaction. **Blue**: interspots, used as physical reference. **Purple**: vertical channel direction for target binding. **Light-Blue**: horizontal channel direction for analyte binding

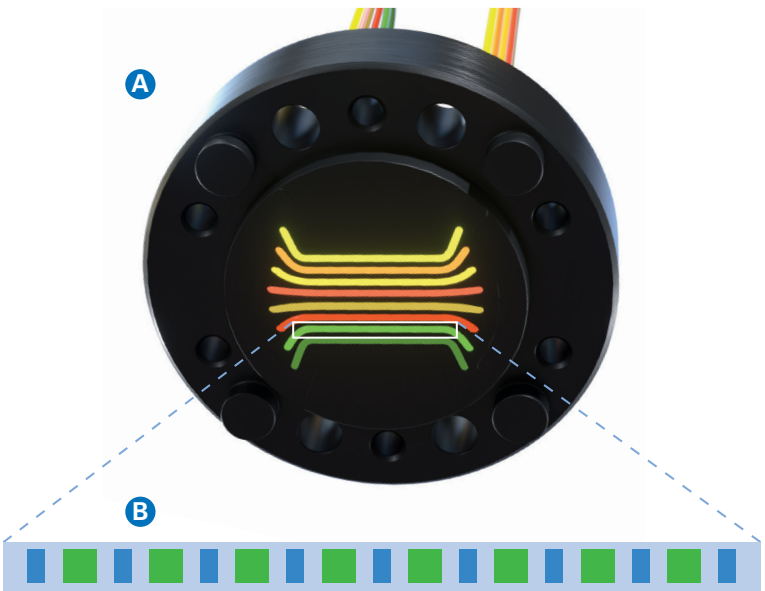

Figure 2
Microfluidic design and sensor spot location within a single channel.
Ⓐ: Simple 8 channel design. Ⓑ: Per channel 8 sensor spots (**green**) and 9 interspots (**blue**) will be read out.

Data is collected using the SPR+ detector as in other Bruker SPR systems. The integration of cutting-edge detection technology and rapid high-throughput data aquisition on the sensor surface results in the most versatile SPR system available on the market.

Microfluidics

The microfluidic manifold consists of a simple 8 channel cartridge. Each channel allows the simultaneous readout of 8 sensor spots plus additional 9 interspots. The channel design as well as the configuration of the sensor spots is shown in Figure 2. After a perpendicular rotation, a total of 64 sensor spots can be used to measure interactions (Figure 1) within one experiment.

Sensor spots

The sensor spots are the main data read-out area within Bruker's SPR #64 system. The injections occur bidirectional, allowing vertical and horizontal injections. Thus final data collection of target/analyte interactions occurs from a total of 64 sensor spots per injection.

Interspots

The interspots can be seen as physical reference spots localized before and after each sensor spot. During immobilization or target capture (vertical injection direction) no activation or target solution will pass over the interspots used during analyte injection (horizontal injection direction). The microfluidics design gives a read-out of 72 interspots plus 64 sensor spots. The analysis software allows both single-reference options, interspot as well as channel referencing.

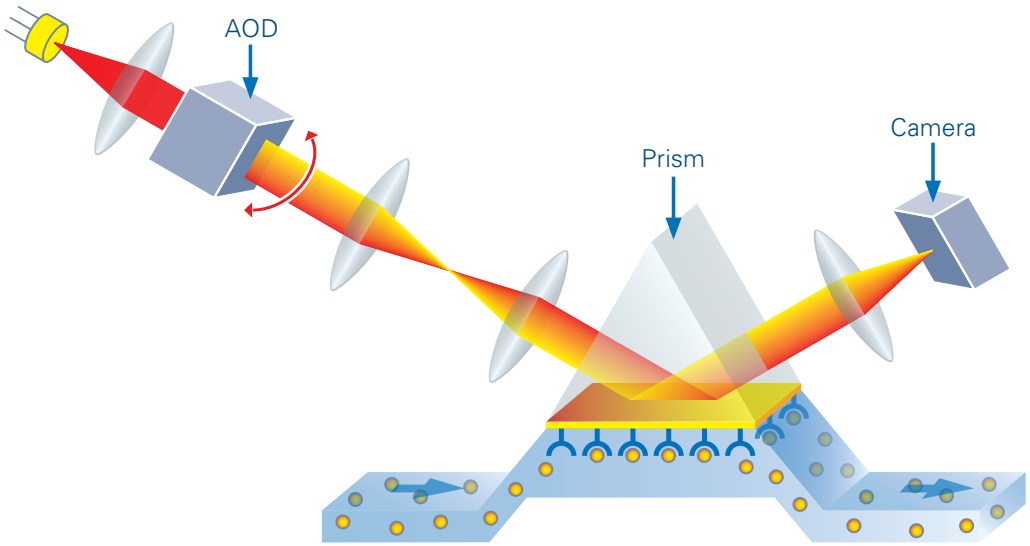

Figure 3
Schematic illustration of the patented SPR⁺ detector, used in all Bruker SPR systems.

Detection and temperature control

In 2007 VanWiggeren *et al.* described a novel optical method for high-sensitivity and high-throughput analysis [1]. This patented detection method is used in all Bruker SPR systems, known as SPR⁺ detection which enables the recognition of molecules with molecular weights of ≥100 Da. A schematic illustration of the detector is shown in Figure 3. Offering a sensitive detector inside a SPR instrument creates new possibilities in the application area as e.g., lower concentrations of targets can be used, thus reducing mass transport limitation effects and improving the quality of kinetic measurements [1, 2]. We demonstrated the power of SPR⁺ detection in the SPR Pro Series in our recent application note [3]. A deviation of no more than 0.01°C from the target temperature is required for reliable SPR measurements [4]. The sophisticated temperature control system in the SPR #64 instrument represents a significant advancement in SPR technology. The combination of highly precise temperature sensors, advanced software, and the innovative heating/cooling assembly ensures that SPR measurements always occur under very stable temperature conditions (< ±0.01°C). Thus, the SPR #64 system operates at peak performance, delivering exceptional results, every time.

Dual prism sensor chip

Bruker's SPR #64 is the first SPR instrument that uses a dual prism sensor. One prism (referred to as the active prism) holds the sensor surface for the experiment while the second prism (referred to as the inactive prism) is used for maintenance purposes. Thus, maintenance commands can be performed automatically after each experiment without removing the sensor chip from the instrument. For example, the system can be cleaned prior to starting the next experiment. A schematic illustration can be seen in Figure 4.

An RFID tag provides consumable-related information, such as date of expiry, information about surface chemistry and batch ID.

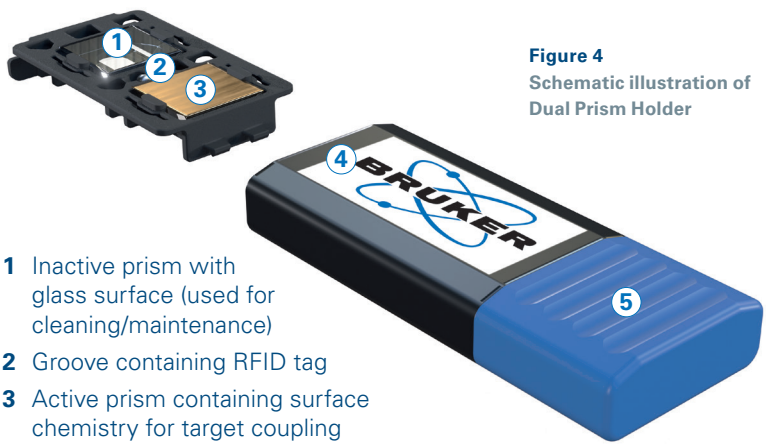

Figure 4
Schematic illustration of Dual Prism Holder

1 Inactive prism with glass surface (used for cleaning/maintenance)
2 Groove containing RFID tag
3 Active prism containing surface chemistry for target coupling
4 Sensor label
5 Rubber handle

Buffer configuration, autosampler and pumps

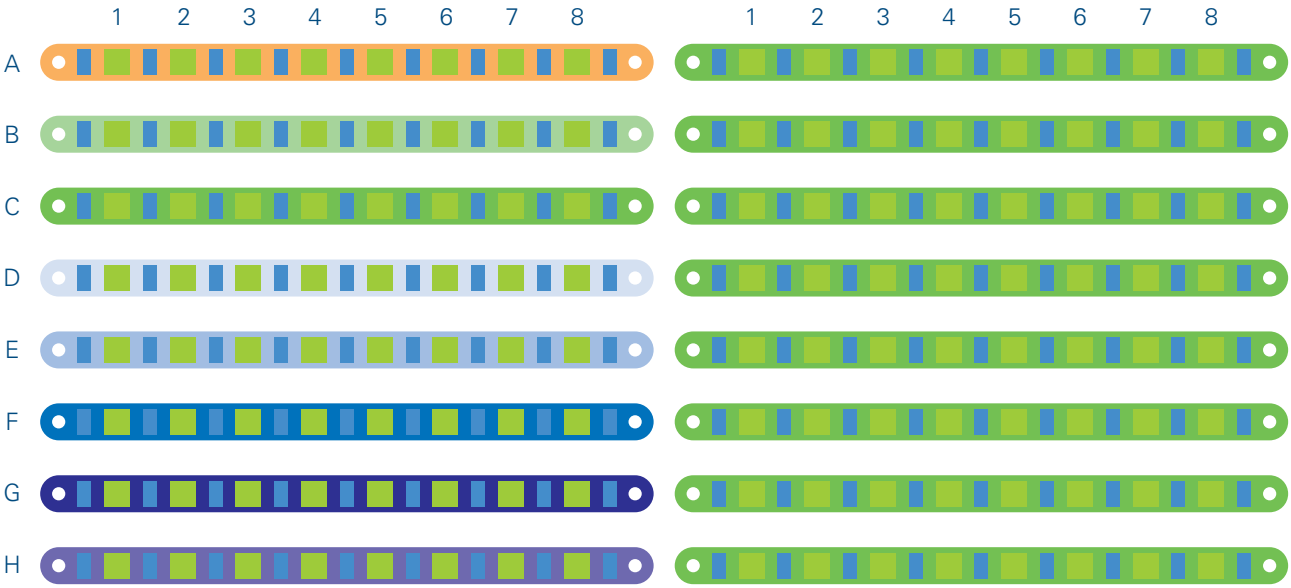

Figure 5
Buffer configuration. Left: Usage of a different buffer per channel. Right: Same buffer in all channels.

Buffer configuration

The instrument allows the sequential usage of up to 3 buffers for all eight channels. Thereby, each buffer solution can be selected within the highly intuitive buffer management of the control software. The change of a selected buffer can happen manually or fully automated during a long-term experiment. Alternatively, up to 8 different buffer solutions can be used in parallel as shown in Figure 5. Especially this multiplexing capability allows the user to investigate several conditions in parallel, such as 8 immobilized targets tested at 8 different conditons in parallel.

Autosampler

Bruker's SPR #64 autosampler offers four plate positions compatible with standard 96- and 384-well microtiter plates. All plates can be temperature controlled in a range from 10-40°C after connecting to an external chiller. A high precision 8-needle head ensures the precise pickup of each sample solution per plate. A trough (2 x 19 mL or 1 x 40 mL) can be used as additonal reagent space.

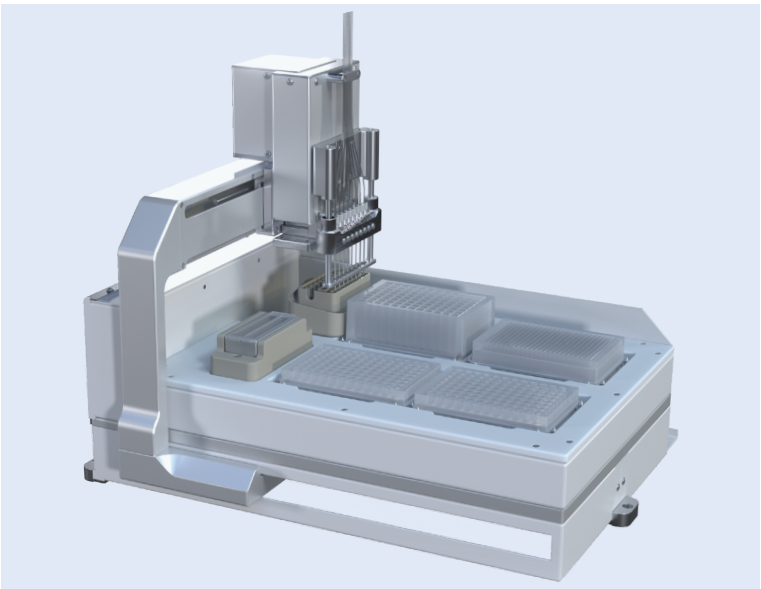

Figure 6
Autosampler of Bruker's SPR #64. The Bruker SPR #64 autosampler features four plate positions, accompanied by a wash station and a reagent trough with a capacity of either 1 x 40 mL or 2 x 19 mL. Furthermore, two reagent pickup positions are available at the wash station.

The injection needles are cleaned with running buffer prior to each sample pick up in a dedicated wash station. This station offers also two reagent pickup positions (e.g., for regeneration solutions) with external tubing connections for extended runtimes. An illustration of the autosampler is shown in Figure 6.

Pumps

Two sets of eight syringe pumps are used within the instrument to supply buffer as well as sample solution. The flow rate ranges from 1-200 µL/min supplied by two sets of 1 mL syringes.

The buffer pump continously supplies running buffer within the 8 channels. An inline degasser will degas the buffer per channel prior to reaching the flowcell.

The sample pump picks up samples and reagents from the plates and injects them into the individual channels of the flowcell. The injection quality can be configured within the control software as well as the usage of injection features.

The pumps facilitate the individual needle control function, as shown in Figure 7. Therefore, only a specific channel can be addressed with the sample, requiring the user to pipette only the corresponding positions in the plate, resulting in increased efficiency and reduced workload.

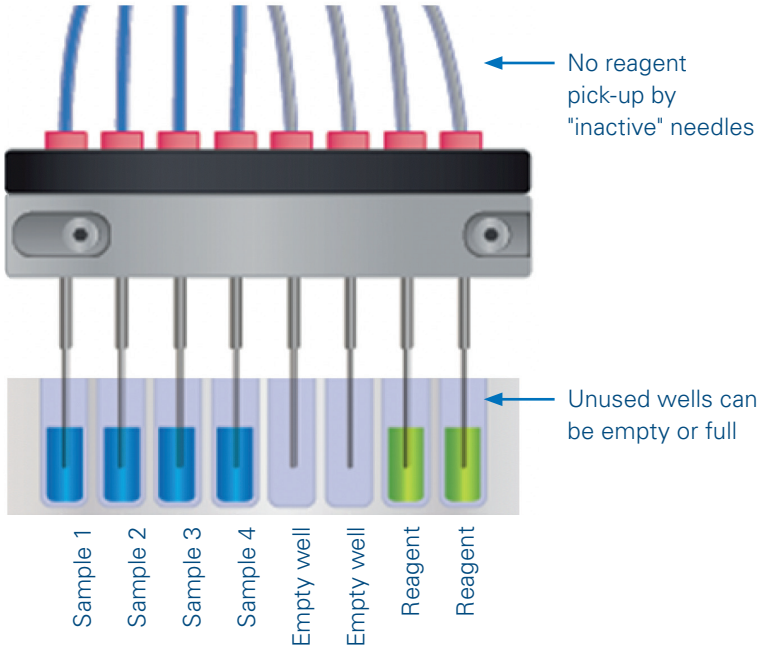

Figure 7
Full flexibility is achieved through Individual Needle Control.
Pre-pipetting is necessary only for the channels of interest, allowing unused vials to remain empty.

References

[1] VanWiggeren *et al.*, (2007). *A novel optical method providing for high-sensitivity and high-throughput biomolecular interaction analysis*

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[3] Bruker SPR App.-Note 1886463: *Pushing the limits of SPR⁺ detection*

[4] Richard BM Schasfoort (2017). *Handbook of Surface Plasmon Resonance 2nd edition*

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Bruker Switzerland AG

Fällanden · Switzerland
Phone +41 44 825 91 11

Bruker Scientific LLC

Billerica, MA · USA
Phone +1 (978) 663-3660

sales.spr@bruker.com – www.bruker.com

Learn more at **www.bruker.com/spr**