

## Microfluidic systems

# Moving plug PCR device – ultra fast nucleic acid amplification

### Quick Facts

- ultra fast real-time PCR within 6min
- melting curve optional
- low-cost consumables
- low-cost instrumentation
- compatible to various sample preparation modules
- OEM option for integration in sample-to-answer platforms

### Introduction

Polymerase chain reaction (PCR) nowadays is an important and commonly used technique for a plentitude of diagnostic applications such as medical diagnostics of infectious diseases. Compared to conventional approaches molecular analysis techniques are often faster, more sensitive and have a higher specificity. The result of a PCR test thereby enables a highly efficient and prompt therapy.

Fraunhofer IMM has developed a smart and robust fully autonomously working real-time PCR module based on the moving liquid plug concept. This module enables an ultra-fast PCR capable of running 30 cycles with real-time fluorescence

detection in just 6 minutes with the potential of integration into complex sample-to-answer platforms.

### Instrument setup

The module consists of an injection molded disposable polycarbonate chip with an adjustable reaction volume that can range from 10 to 25  $\mu\text{l}$ . It has an easy to handle inlet to load the PCR solution. The meandering fluidic channel with a closed air reservoir at the distant end is arranged above two or optional three individually controlled heating zones. During operation, these zones are constantly heated to the required processing temperatures of the PCR, and the PCR solution plug is moved back and forward with a syringe pump pushing against a dead end. A conventional USB camera allows detection of the plug position inside the chip. In addition, the camera is capable of real-time measurement of fluorescence dyes or probes in the plug. Excitation is enabled by high power LEDs combined with filters.

### Competences

Due to the locally fixed heating zones, this new concept omits the cyclic heating and cooling process used in common PCR machines and, hence, leads to an exceptionally fast temperature change in the PCR solution plug. The periodical movement of

the PCR solution causes internal vortices, which enhances an efficient reagent mixing and supports a homogeneous temperature distribution in the plug. The overall cycling time was optimized by simulations (ANSYS CFX) in combination with real sample experiments to reach the best possible compromise between plug speed and heating/cooling time.

With the camera based fluorescence detection the module generates high quality quantitative PCR amplification plots. In addition, sensitive melting point analysis comparable to data obtained from commercial real-time cyclers can be carried out. These features provide the user with all information needed to analyze the PCR products.

Experiments showed that the PCR module is not only limited to amplification of purified nucleic acids but is also capable of successfully handling whole blood samples with a direct blood PCR. The PCR solution can be loaded directly into the chip.

### Division Diagnostics at a glance

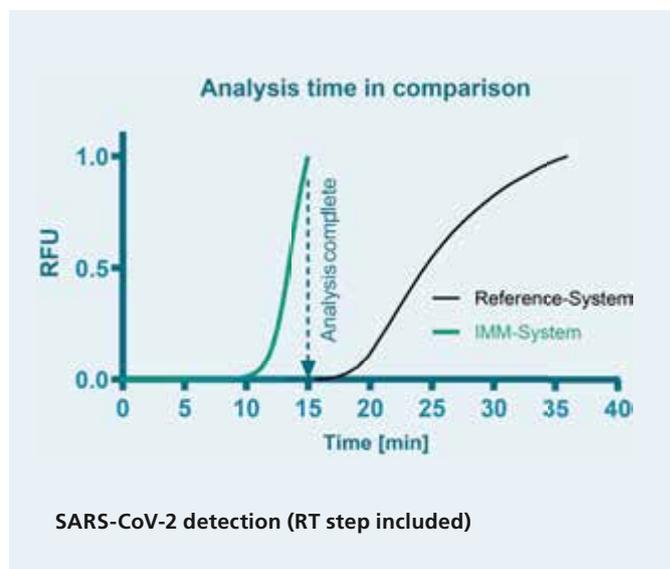
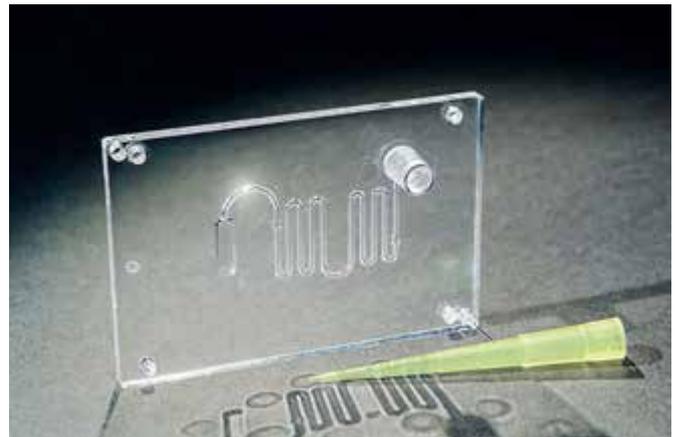
We provide R&D for microfluidic-based analysis systems with applications in life sciences, medical research and diagnostics, food safety or biotechnology.

Our microsolutions enable the analysis and monitoring of biological parameters such as proteins, ions, small molecules, RNA, DNA or pathogenic organisms.

The key enabler for fully automated point-of-care systems is our extensive experience in the miniaturization of lab preparation methods, their integration with microsystems, including measurement methods for sample analysis, such as PCR, nucleic acid extraction and purification, immunoassays or ELISAs or flow cytometry.

### Our partners benefit from

- low cost consumables (disposable)
- minimized reagent consumption for monitoring purposes
- minimal hands-on time or full automation



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