

LabDisk – novel centrifugal microfluidic unit operations for sample-to-answer analysis and Microfluidic Apps



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Summary

A novel set of unit operations for the LabDisk platform enables point of care (POC) sample-to-answer nucleic acid testing (NAT). Unit operations are compatible with monolithic manufacturing processes, e.g. microthermoforming of foils. A novel processing device, the “LabDisk player” enables spinning of the LabDisk and air mediated real time PCR. Sample-to-answer analysis is demonstrated for pathogenic microorganisms from blood serum. GeneSlices for automation of multiplex real-time PCR extend the functionality of standard laboratory devices (Microfluidic Apps).

Motivation

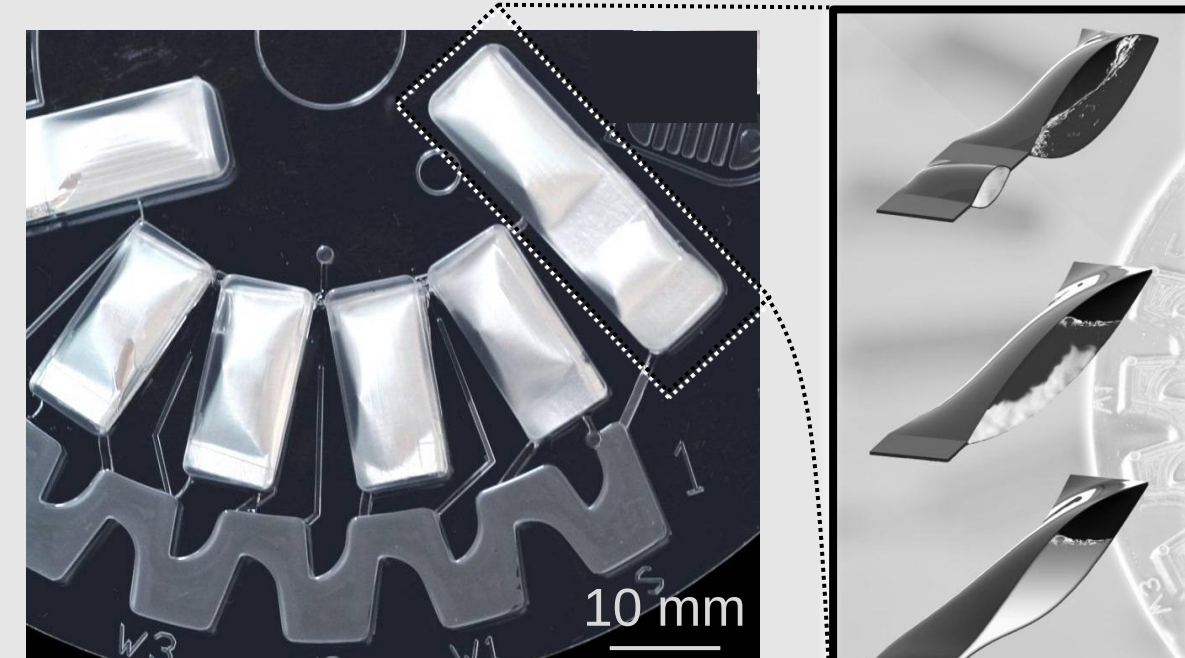
Despite enormous research efforts in the field of microfluidic lab-on-a-chip systems, yet, no products for fully integrated sample-to-answer POC NAT entered the market. Market requirements can be addressed by platform solutions. Market entry barriers can be lowered by using standard laboratory instruments.

Microfluidic unit operations for POC NAT

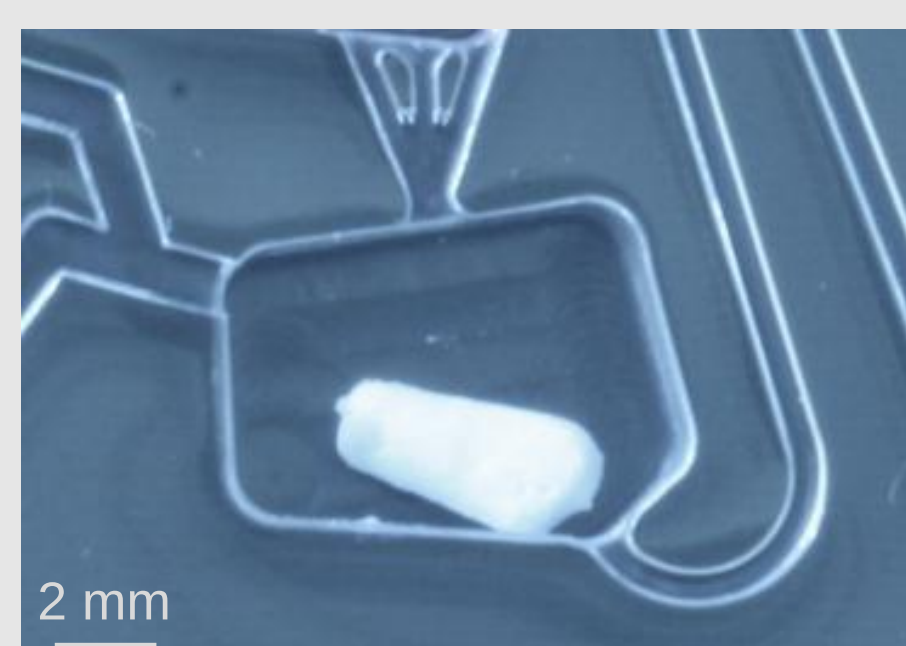
A comprehensive set of microfluidic unit operations is provided, compatible with a monolithic, low-cost manufacturing process.



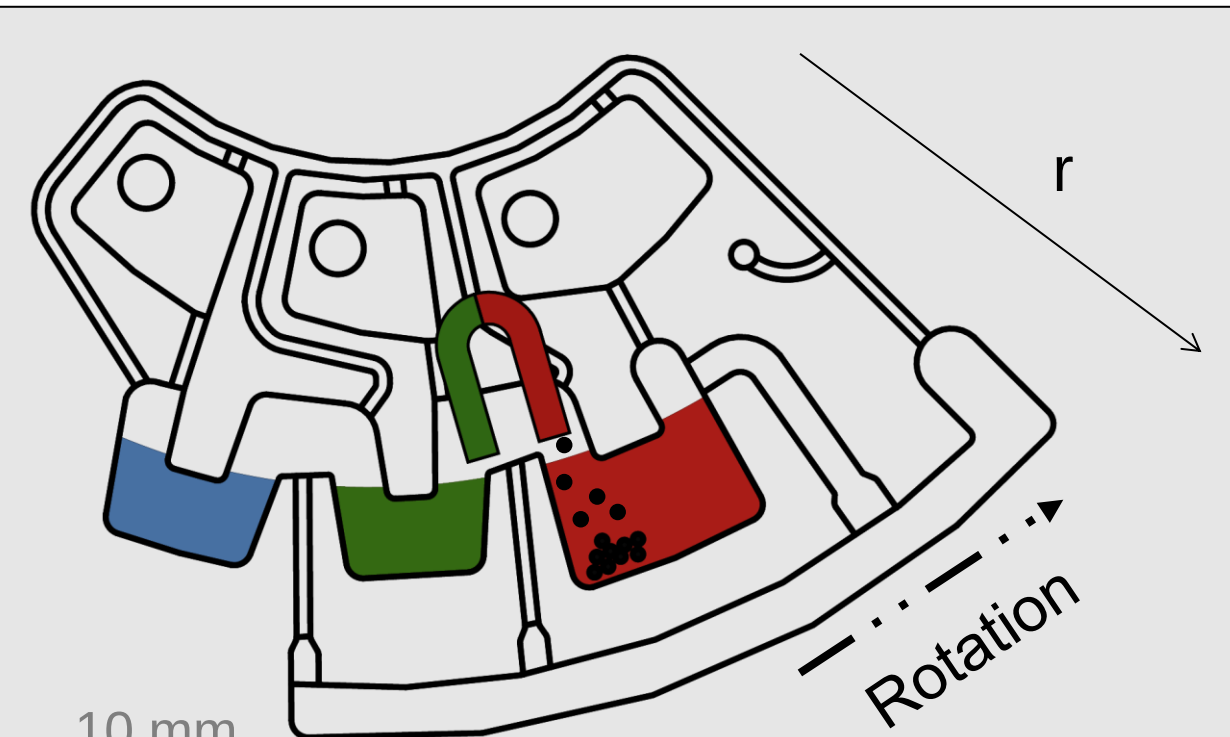
Closable sample inlet, monolithically fabricated by microthermoforming.



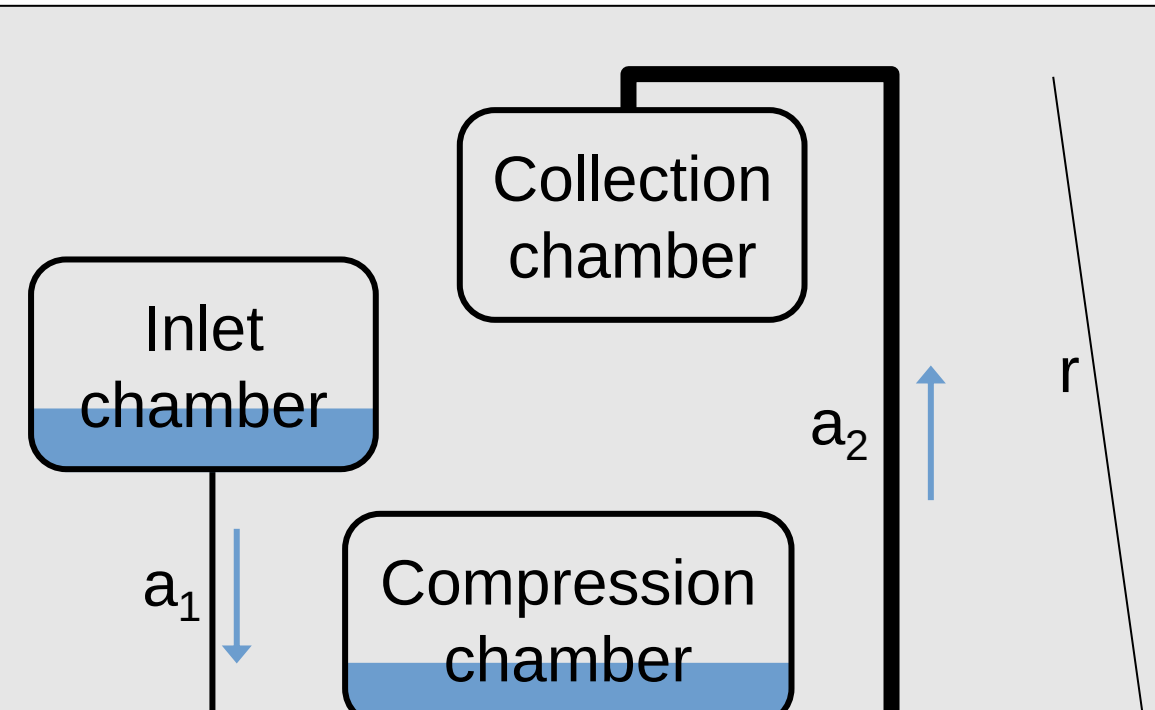
Prestorage of liquid & dry reagents in stickpacks and centrifugal release.



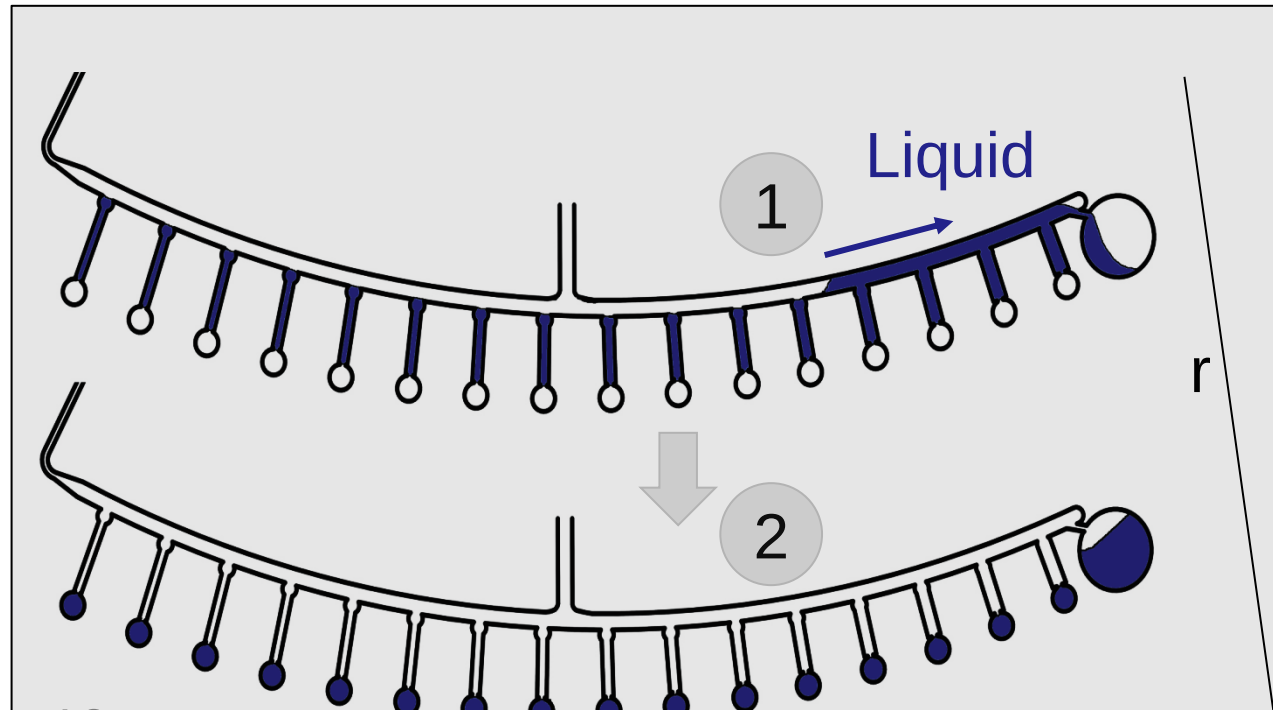
Prestorage of lyophilized reagent pellets (Polymerase)



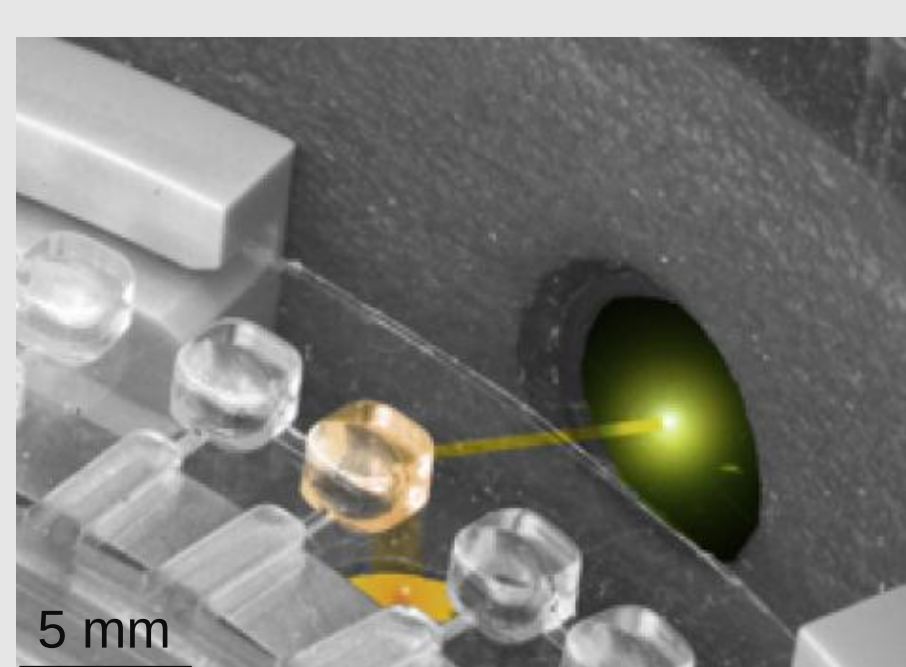
Nucleic acid extraction by magnetic beads and a stationary magnet



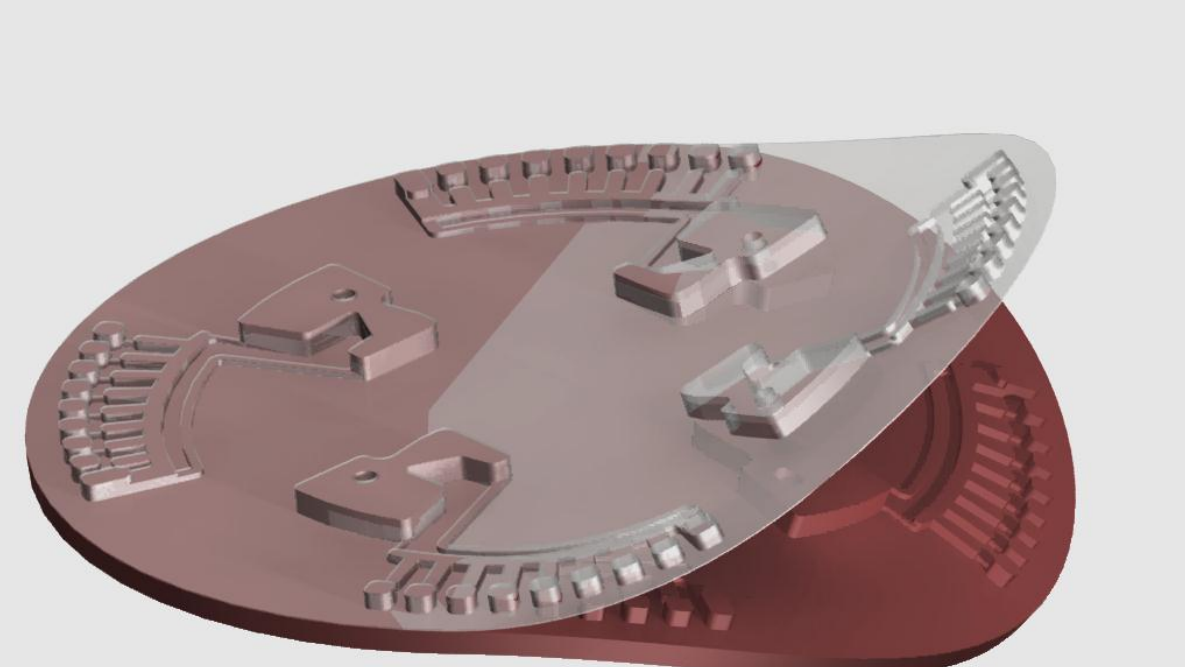
Centrifugo-pneumatic radially inward pumping of liquids ($a_1 < a_2$).



Centrifugo-(thermo)pneumatic aliquoting (cross contamination free).

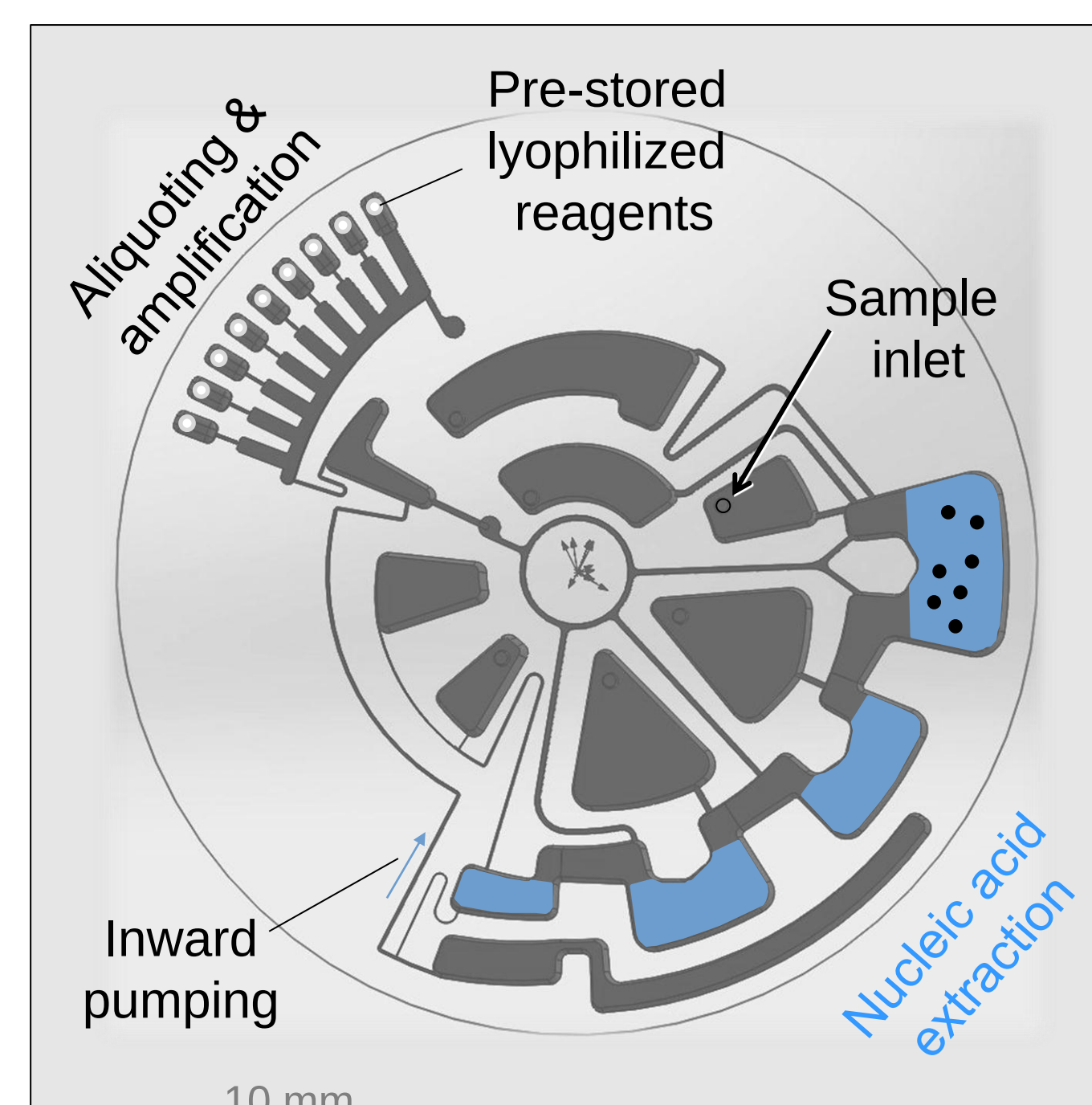


Nucleic acid amplification with real-time fluorescence detection.



Manufacturing: microthermoforming.

Sample-to-answer and Microfluidic Apps



LabDisk - Integrated microfluidics for sample-to-answer-analysis.

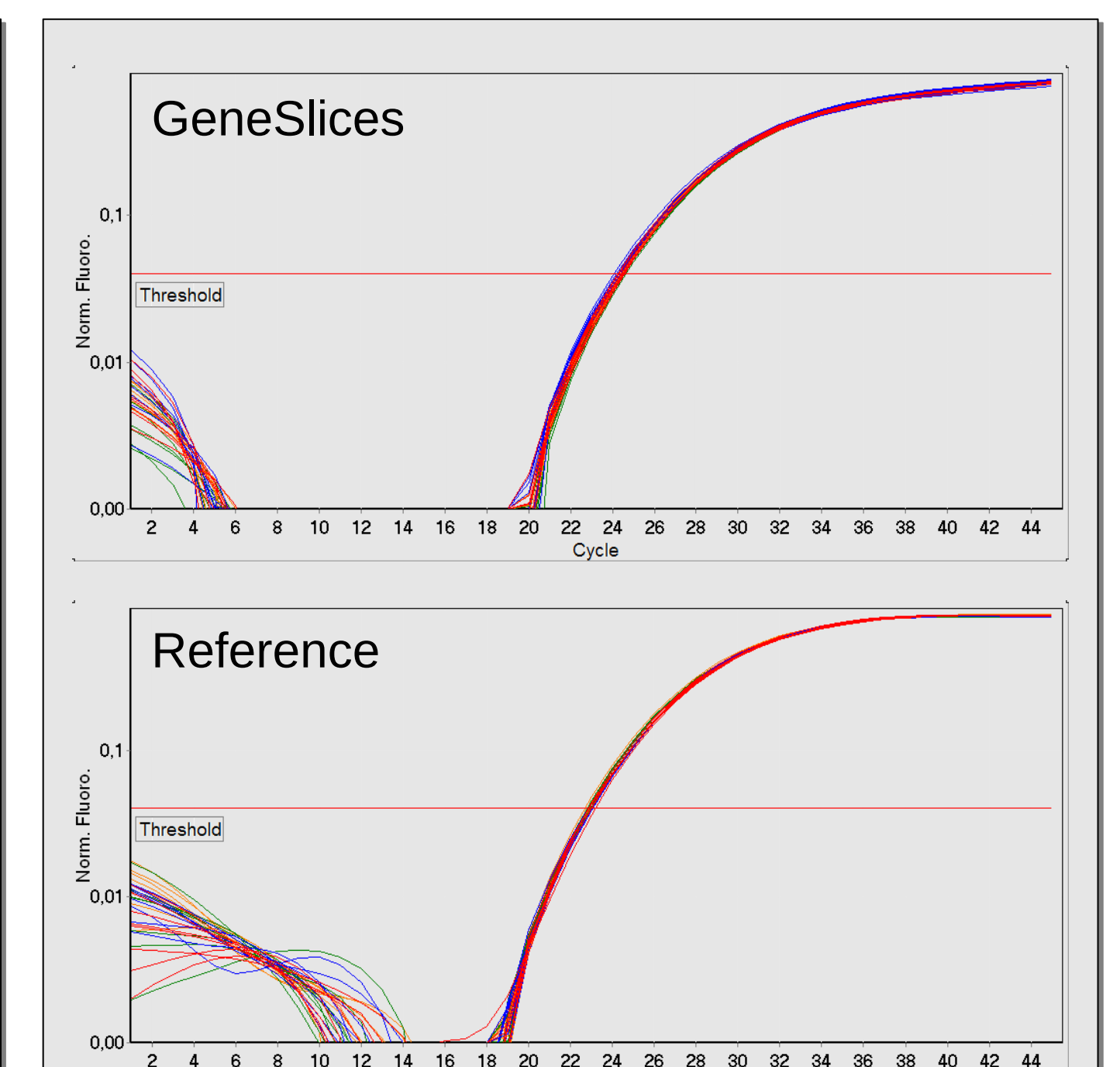


LabDisk processing device for spinning, thermocycling and real-time detection.

For demonstration of the automated sample-to-answer workflow, 1.6×10^6 genome equivalents of *Staphylococcus aureus* in a blood serum sample were successfully detected in approximately 3 hours (~35 min. lysis and DNA extraction; 2 h 30 min. amplification by thermocycling).



GeneSlices as Microfluidic Apps for multiplex PCR in standard Rotor-Gene.



Amplification plot of real-time PCR analysis of human growth factor gene.

Microfluidic Apps extend the functionality of existing devices. The GeneSlice for multiplex real-time PCR can be operated in off-the-shelf Rotor-Gene (QIAGEN) thermocyclers and automates centrifugo-thermopneumatic aliquoting of PCR master mix into 8 reaction cavities with different pre-stored primers and probes.

Conclusion

The centrifugal microfluidic LabDisk platform together with the novel microfluidic unit operations, the monolithic foil based manufacturing approach, and the LabDisk player provides a comprehensive system for fully automated nucleic acid testing. GeneSlices offer an attractive shortcut to market for POC NAT.

Acknowledgements

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Partner

