

Nanoliter-Scale PCR Using the NANOlabor™ System

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Purpose

To validate that PCR reactions miniaturized to 400 nL using the NANOlabor system maintain amplification performance, precision, and contamination control comparable to conventional microliter-scale workflows.

Background

Miniaturization of PCR workflows enables significant reagent cost savings and higher throughput, but introduces challenges related to precision dispensing and contamination control. The NANOlabor platform addresses these challenges through non-contact dispensing and disposable-tip architecture.

Challenge

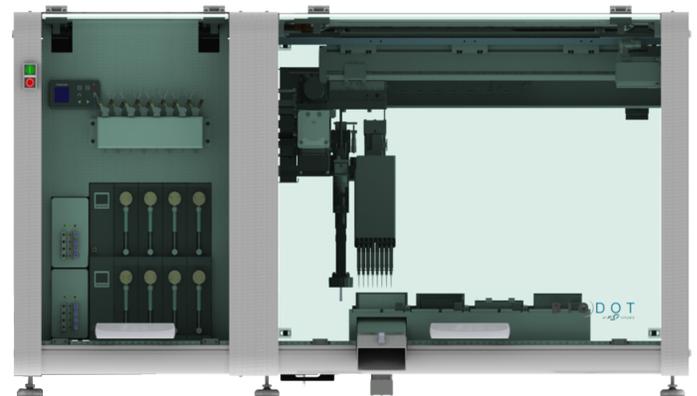
Achieving reliable, contamination-free PCR amplification at nanoliter volumes with acceptable C_q variability and dispensing precision.

Solution

The NANOlabor, engineered to support non-contact single-use disposable tips, environmental control, and full compatibility with standard PCR labware and chemistries, enables robust PCR setup at nanoliter scale.

Materials

- NANOlabor Gen 1.
- 384-well optical PCR plates.
- TaqMan-compatible PCR reagents.
 - 4× DNA Template - 100 nL.
 - 4× Primer-Probe Mix - 100 nL.
 - 2× Master Mix - 200 nL.
- Disposable tips.



NANOlabor System

Method

Setup

PCR reactions were prepared on the NANOlabor system using a chilled aluminum deck maintained at 15 °C and controlled chamber humidity.

Process

Each 400 nL reaction consisted of 100 nL DNA template, 100 nL primer-probe mix, and 200 nL master mix dispensed via non-contact disposable tips into a 384-well plate.

Additional Tests and Processes

No-template controls were included to verify contamination control and system cleanliness.



Dave Pai

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Dave has built his career in customer-facing scientific roles, specializing in training, support, and troubleshooting for genomics and molecular biology platforms. He brings a strong foundation in molecular biology, biochemistry, and genomics to his role at BioDot, where he applies his expertise to optimize low-volume dispensing technologies. His focus is on helping customers improve efficiency and reduce operational costs within their existing workflows.

Results

NANOLab-prepared reactions demonstrated average Cq values (~26.6) comparable to 5 µL manually pipetted controls (~26.4). Dispensing CVs were below 2.5%, and no amplification was detected in no-template controls.

- 90% reduction in reagent usage (5 µL → 400 nL).
- High dispensing precision at nanoliter scale (CV <2.5%).
- Zero detectable cross-contamination, enabled by disposable tips.
- PCR performance equivalent to conventional manual workflows.

These results confirm that PCR miniaturization using disposable tips does not compromise data integrity while enhancing contamination control.

Parameter	NanoLab	Manual Pipetting
Reaction Volume	400 nL	5 µL
Average Cq	~26.6	~26.4
Cq CV (%)	~1.75%	<1%
Dispense CV (%)	<2.5%	N/A
Replicates	6	3
NTC Amplification	None detected	None detected

Conclusions

This experiment demonstrates that the NANOLab system delivers robust, reproducible nanoliter-scale PCR using disposable-tip non-contact dispensing. Quantitative performance data show equivalence to traditional microliter workflows, while disposable tips provide enhanced contamination control and regulatory confidence. Together, these results establish NANOLab as a technically achievable, scalable, and commercially viable solution for next-generation genomics and diagnostics laboratories.

Product Overview

NANOLab is a nanoliter-precision liquid handling platform designed to miniaturize multiomics workflows while preserving analytical performance, reproducibility, and contamination control. The system enables high-throughput setup at sub-microliter volumes using non-contact dispensing with disposable tips, making it well suited for genomics and molecular diagnostics laboratories focused on cost efficiency, scalability, and contamination-sensitive workflows.

Functionality and Design Features

Feature	Description	Achievability
Non-contact dispensing	Precise aspiration and dispense of PCR reagents without touching the reaction well	Demonstrated at 400 nL
Contamination control	Disposable tips combined with non-contact delivery	No amplification in NTCs
Environmental control	15 °C chilled deck and chamber humidity maintained	Prevents evaporation
Plate compatibility	Standard 384-well PCR plates	Immediately deployable
Chemistry compatibility	Compatible with TaqMan™ and equivalent PCR chemistries	Experimentally verified