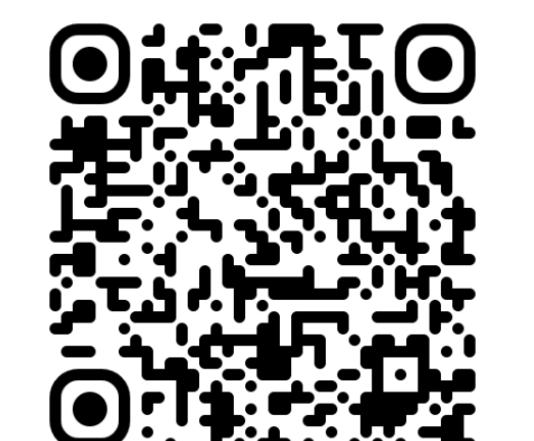


# PEARL-B: A HANDHELD DIAGNOSTIC DEVICE FOR POINT-OF-CARE EARLY ANALYSIS USING RAPID LOOP-MEDIATED ISOTHERMAL AMPLIFICATION FOR BREAST CANCER



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## Introduction

### Urgent need for rapid, accessible diagnostics [1]

- ❖ Early detection of diseases is crucial, but current molecular tests are slow, laboratory-dependent, and require skilled personnel.
- ❖ Portable molecular devices offer fast, reliable testing at the bedside or in remote and low-resource settings, revolutionizing early diagnosis and healthcare access.

### Engineering challenges in handheld POC device development [1]

- ❖ Miniaturize complex assays without compromising sensitivity or accuracy.
- ❖ Integrate preparation, amplification, and detection into a simple, all-in-one system.
- ❖ Ensure low-cost, low-power, and reliable thermal performance for field use.

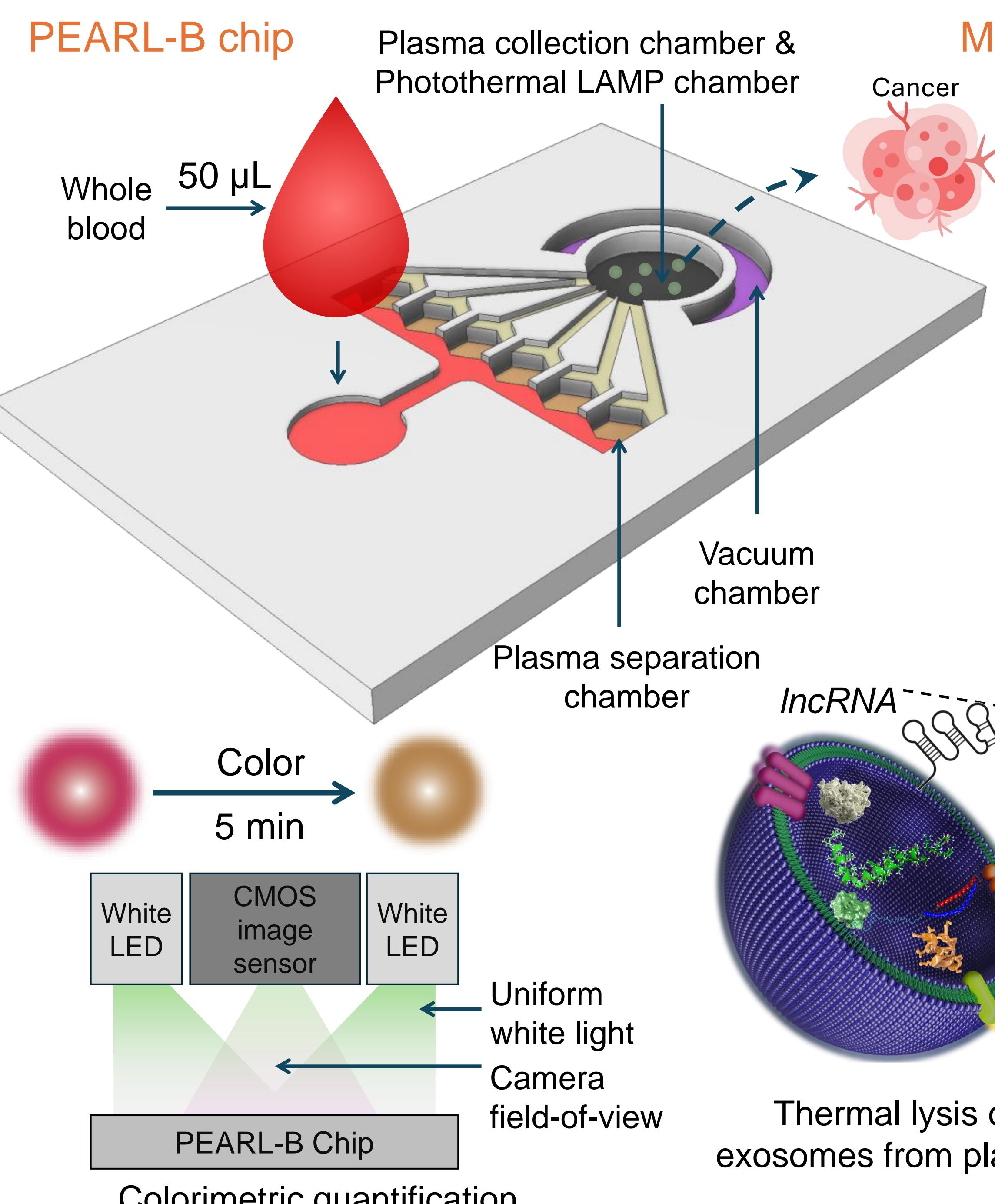
### Strategies to overcome these challenges [2,3]

- ❖ Design compact microfluidic modules for automated sample handling and rapid LAMP reactions.
- ❖ Employ passive or magnetic target isolation with modular, user-friendly electronics to enhance specificity.
- ❖ Implement energy-efficient heating and robust detection with standardized reagents for consistent, reliable results.

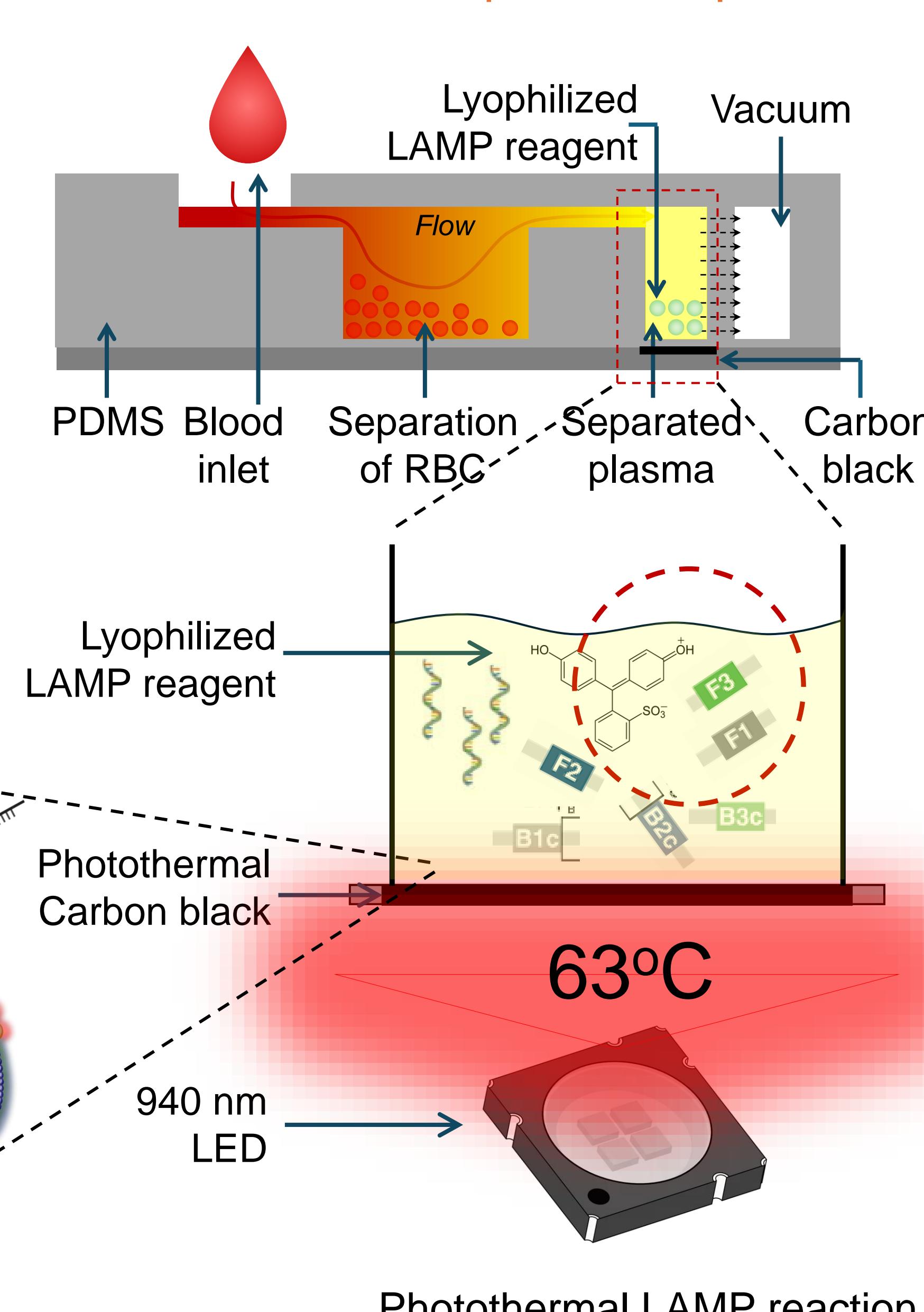
### Application in early breast cancer detection [4]

- ❖ PEARL-B device enables direct detection of breast cancer-specific nucleic acid (NA, i.e., HOTAIR lncRNA) biomarkers from clinical samples.
- ❖ Delivers rapid, on-site molecular results for timely and accurate diagnosis.
- ❖ Adaptable for other diseases, supporting broad clinical and remote healthcare screening.

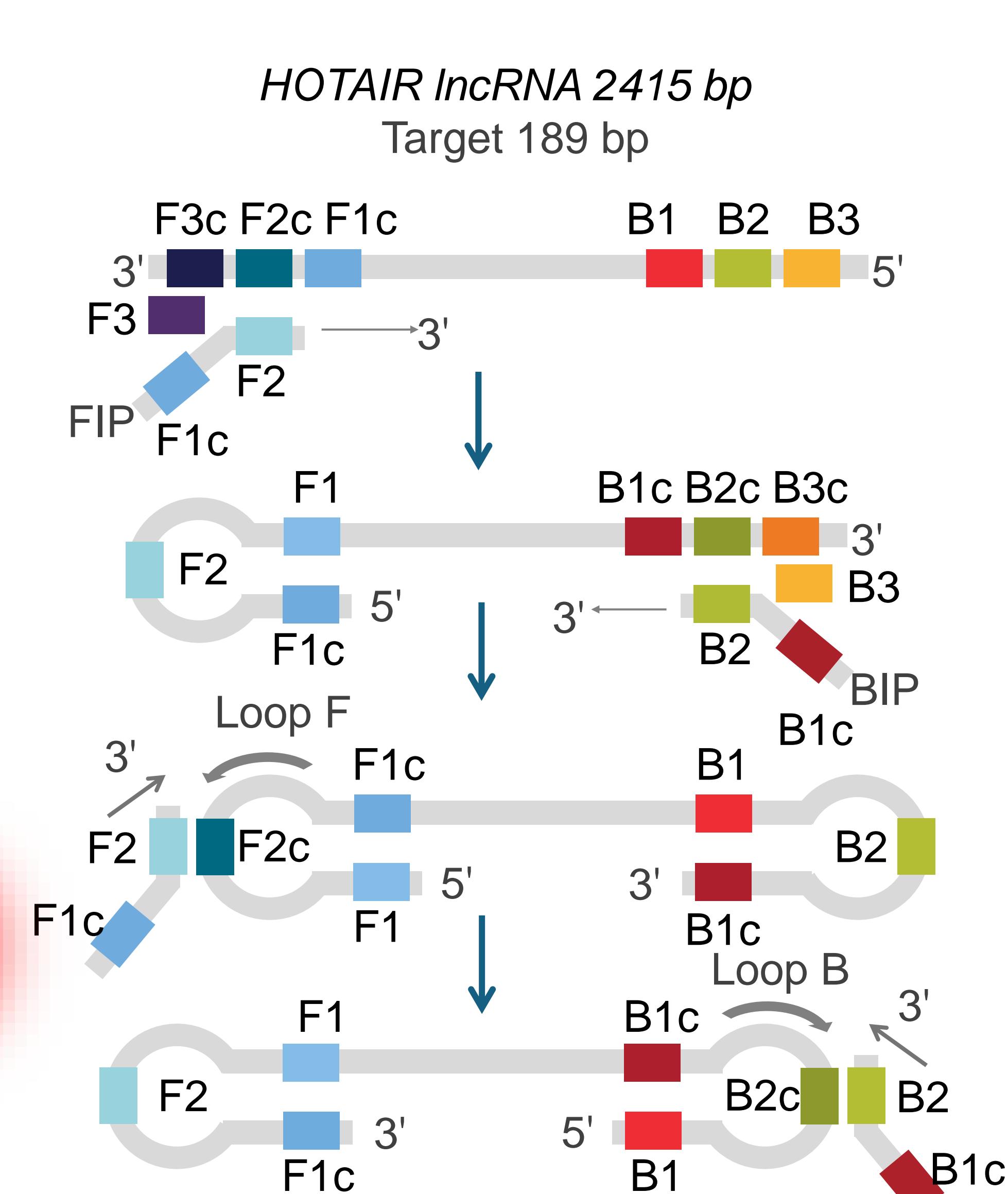
## Methods



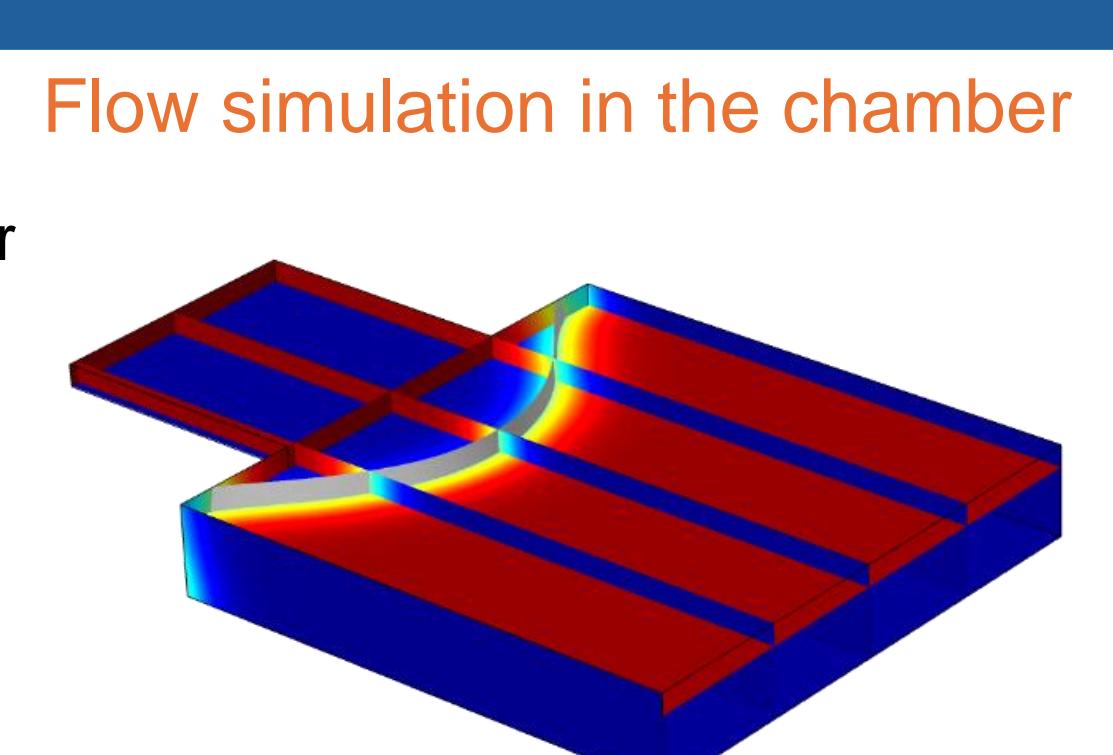
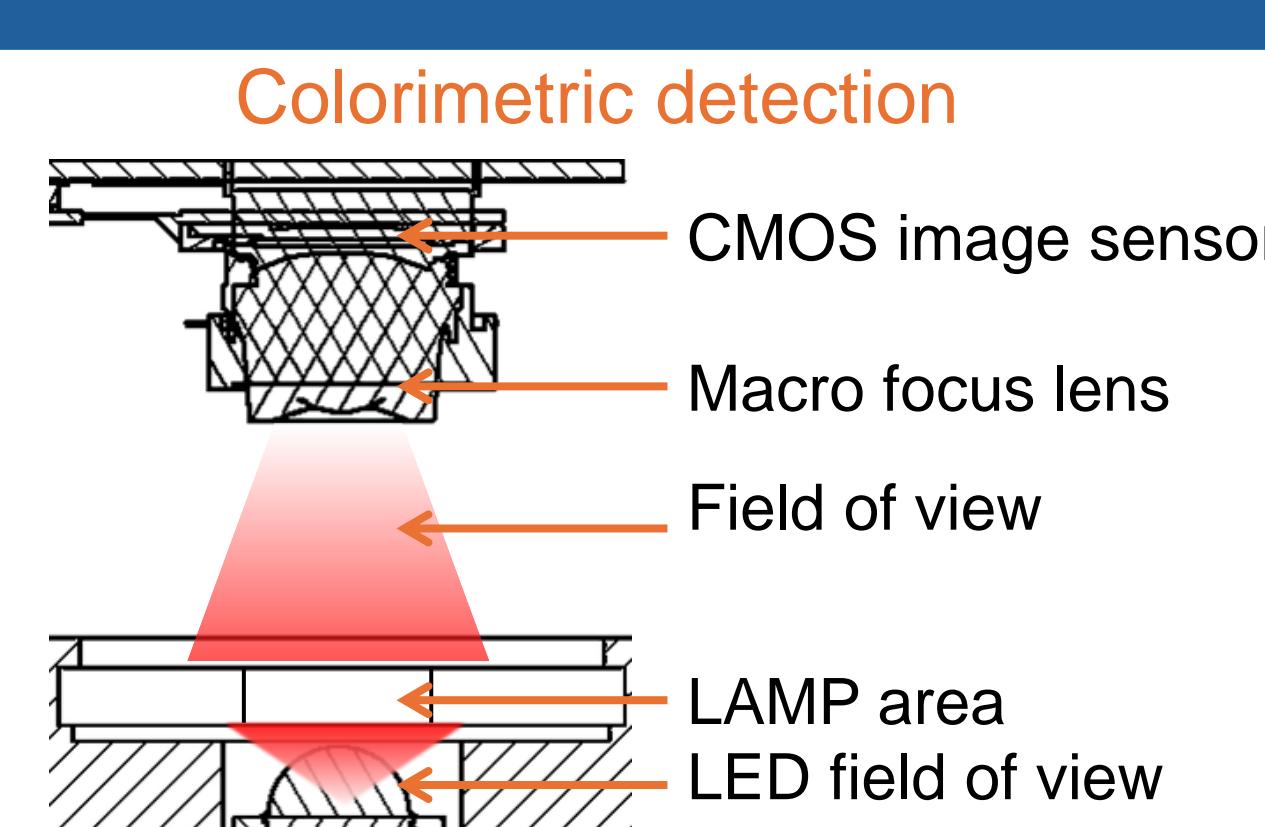
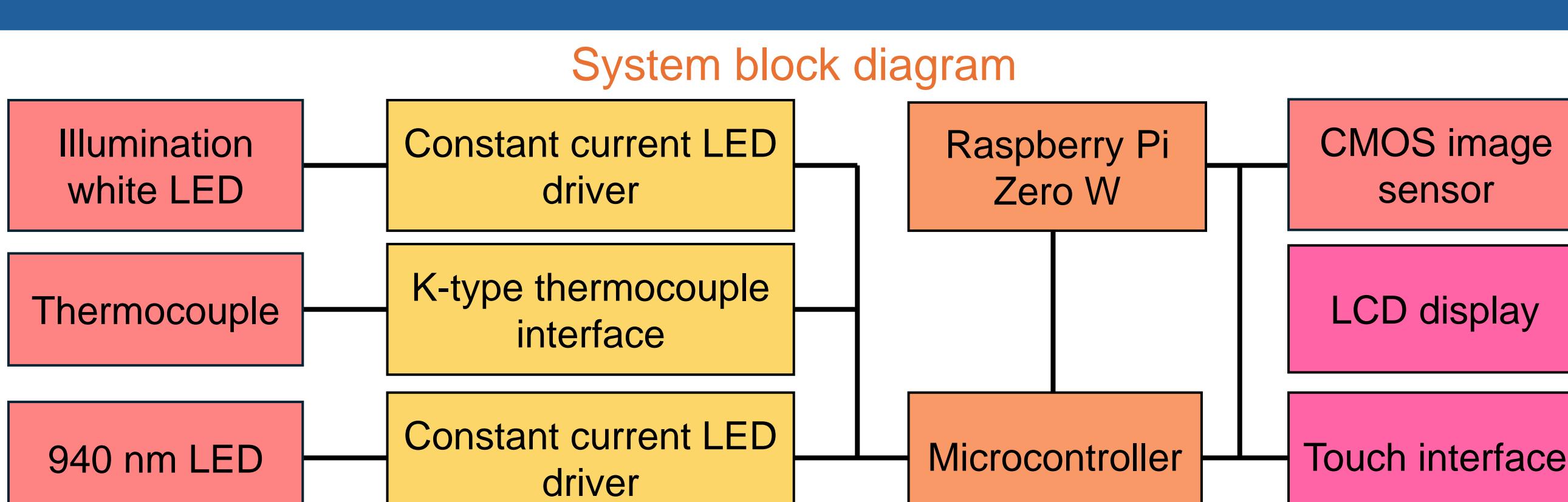
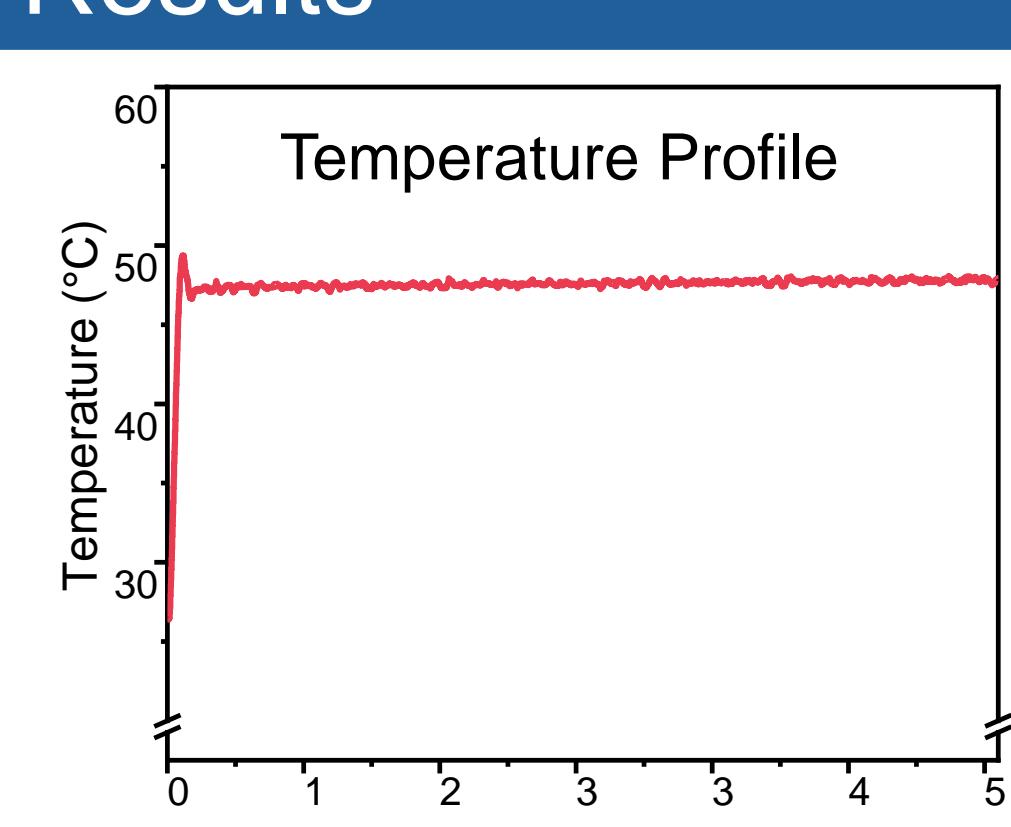
### Mechanism of blood and plasma separation



### Photothermal enhanced LAMP mechanism



## Results



## Conclusion

PEARL-DX represents a universal device capable of rapid, POC detection of a range of NA biomarkers for various diseases of interest, enabling timely diagnosis and improving healthcare access in diverse clinical and remote settings.

## References

- [1] Shrestha, K. & Shiddiky, M. J. A., et al., "Challenges in the development and implementation of point-of-care handheld qPCR Devices.", *Small*, 2025, Accepted Article.
- [2] Shrestha, K. et al., "Mobile efficient diagnostics of infectious diseases via on-chip RT-qPCR: MEDIC-PCR.", *Adv. Sci.*, 2023, **10**, 2302072.
- [3] Shrestha, K. et al., "Infectious disease diagnostic device using rapid and efficient qPCR assays on a multi-target chip: idream-qPCR.", *Microsyst. Nanoeng.*, 2025, **11**, Article No.: 143.
- [4] A breast cancer-specific lncRNA assay (PEARL-B Device) is undergoing advanced optimization with commercial and IP potential, and its performance is being validated in pre-clinical and clinical studies.

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