

Thin-film heater technology for probing DNA hybridization kinetics

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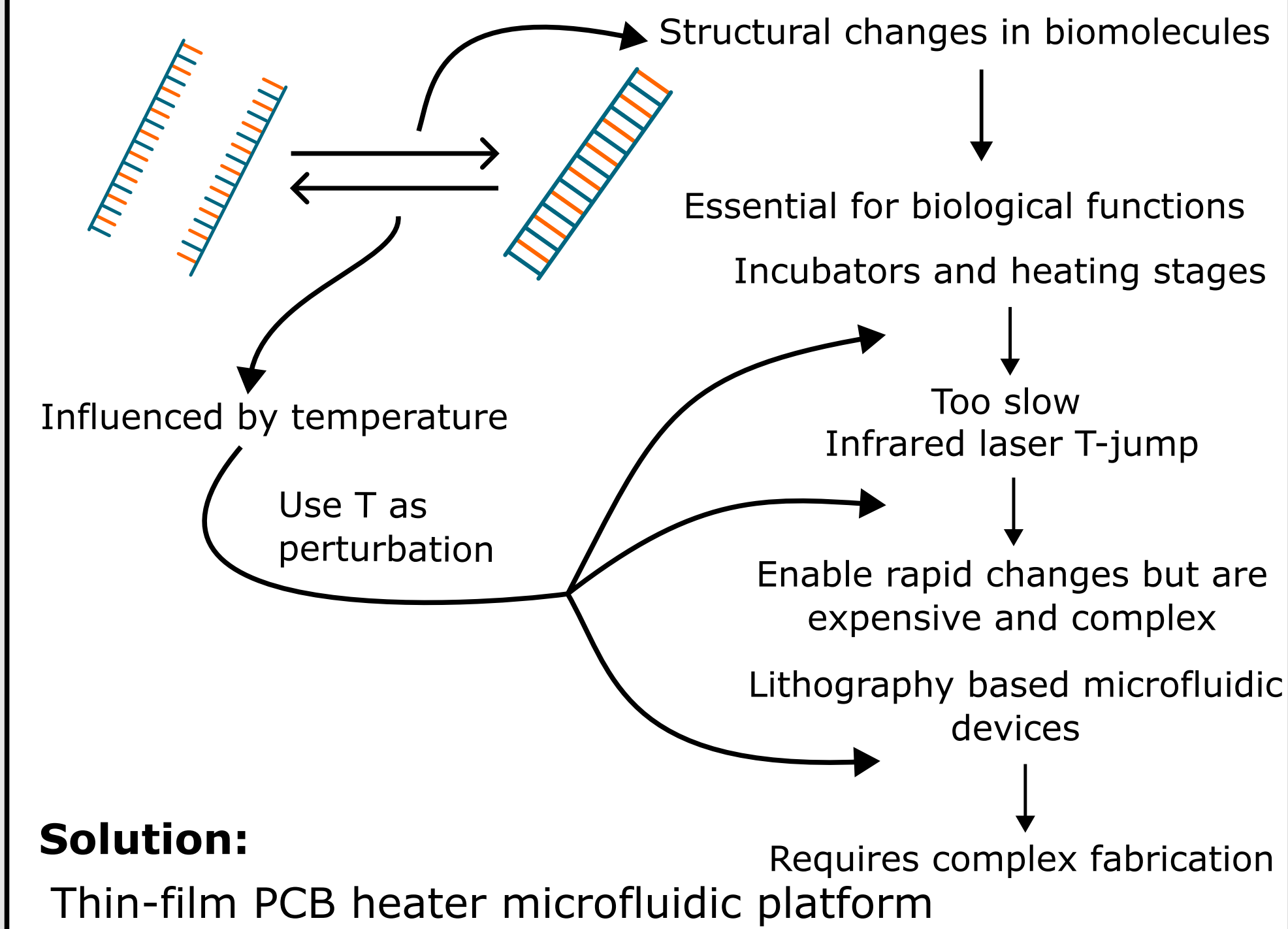
3. UHasselt, Dynamic Bioimaging Group, Biomedical Research Institute, Agoralaan, 3590 Diepenbeek, Belgium

4. UHasselt, Theory Lab, Faculty of Sciences, Agoralaan, 3590 Diepenbeek, Belgium

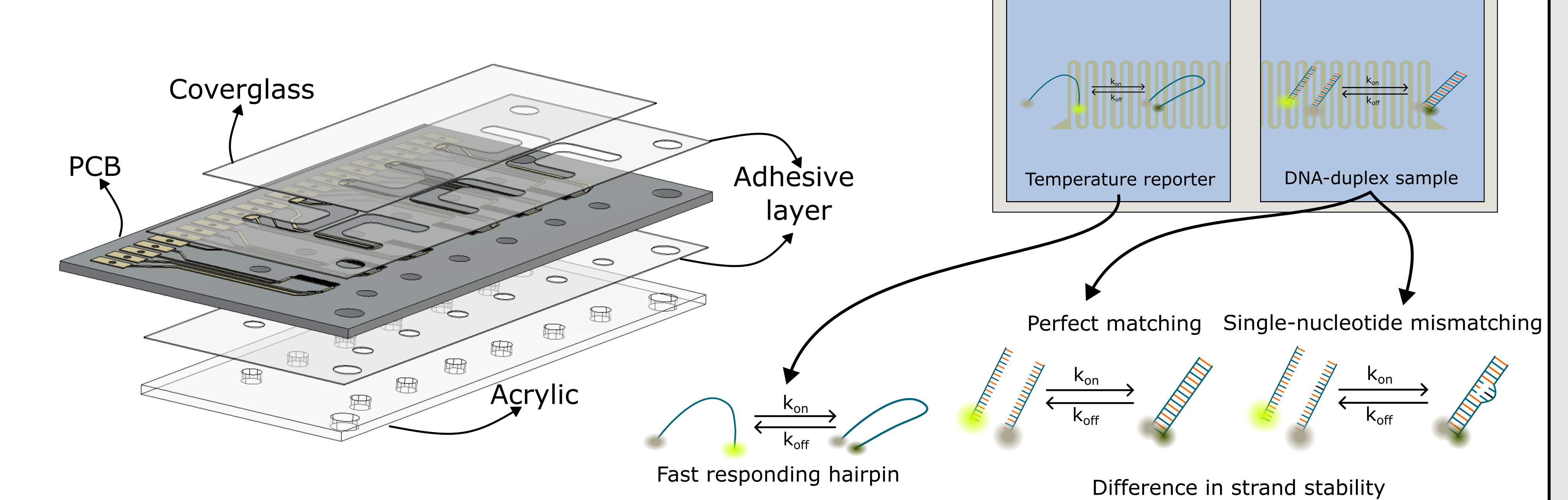
IMO-IMOMEC

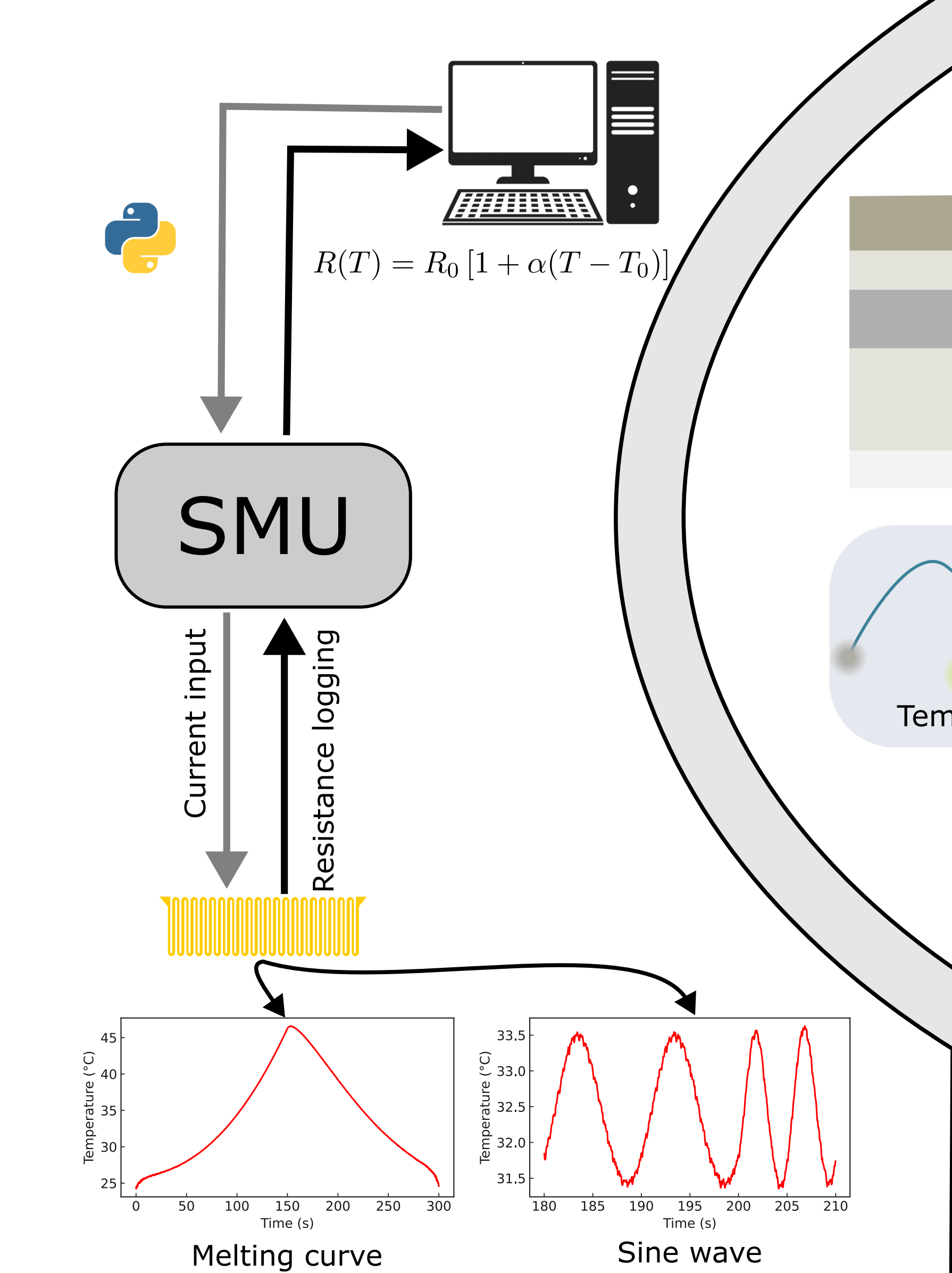
PROBLEM STATEMENT



MICROFLUDIC IMAGING SETUP

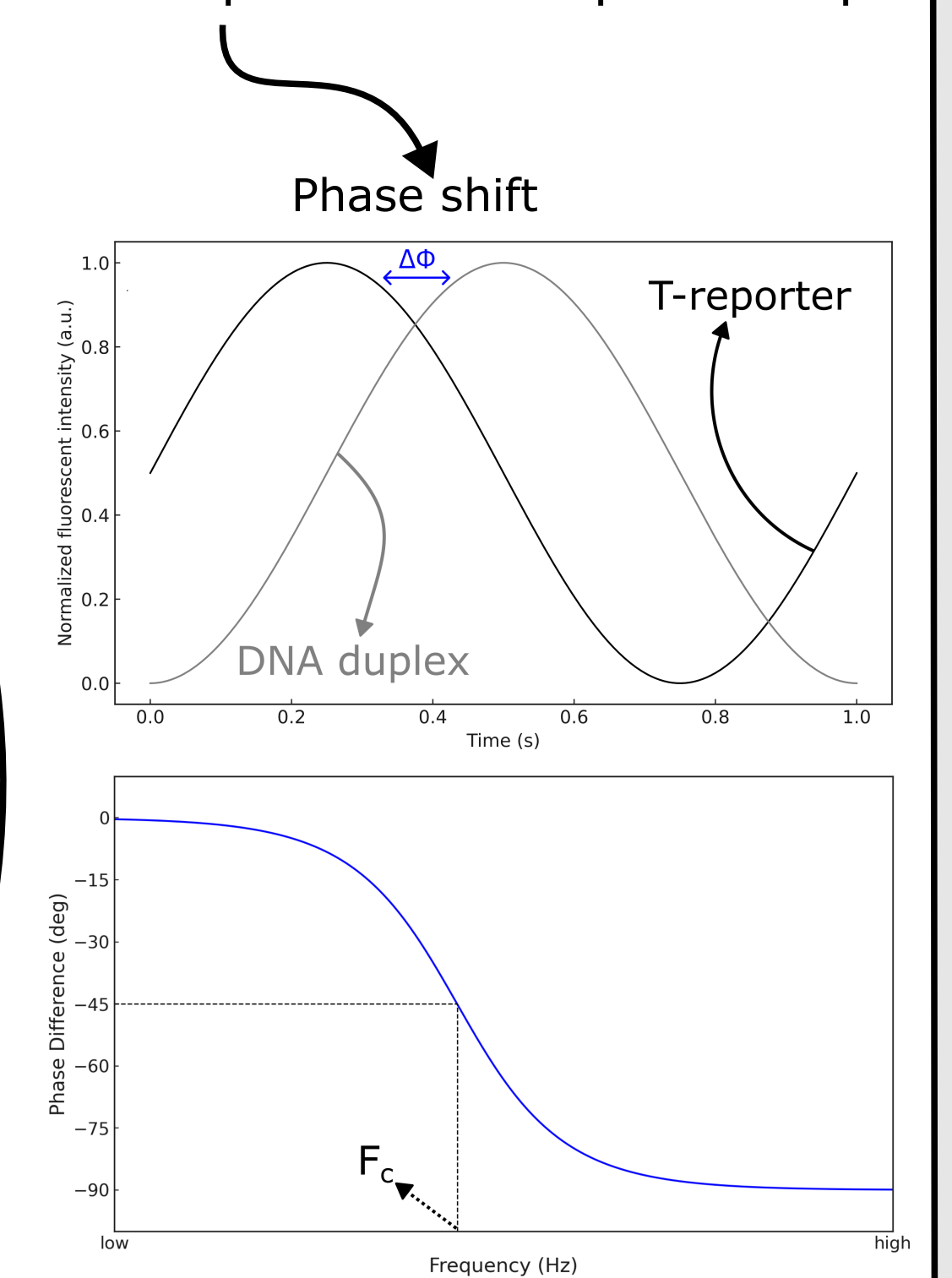


TEMPERATURE CONTROL



FREQUENCY DOMAIN ANALYSIS - THEORY

Fast Fourier Transformation → Phase extraction
 Difference between T-reporter and duplex sample



Frequency (Hz)

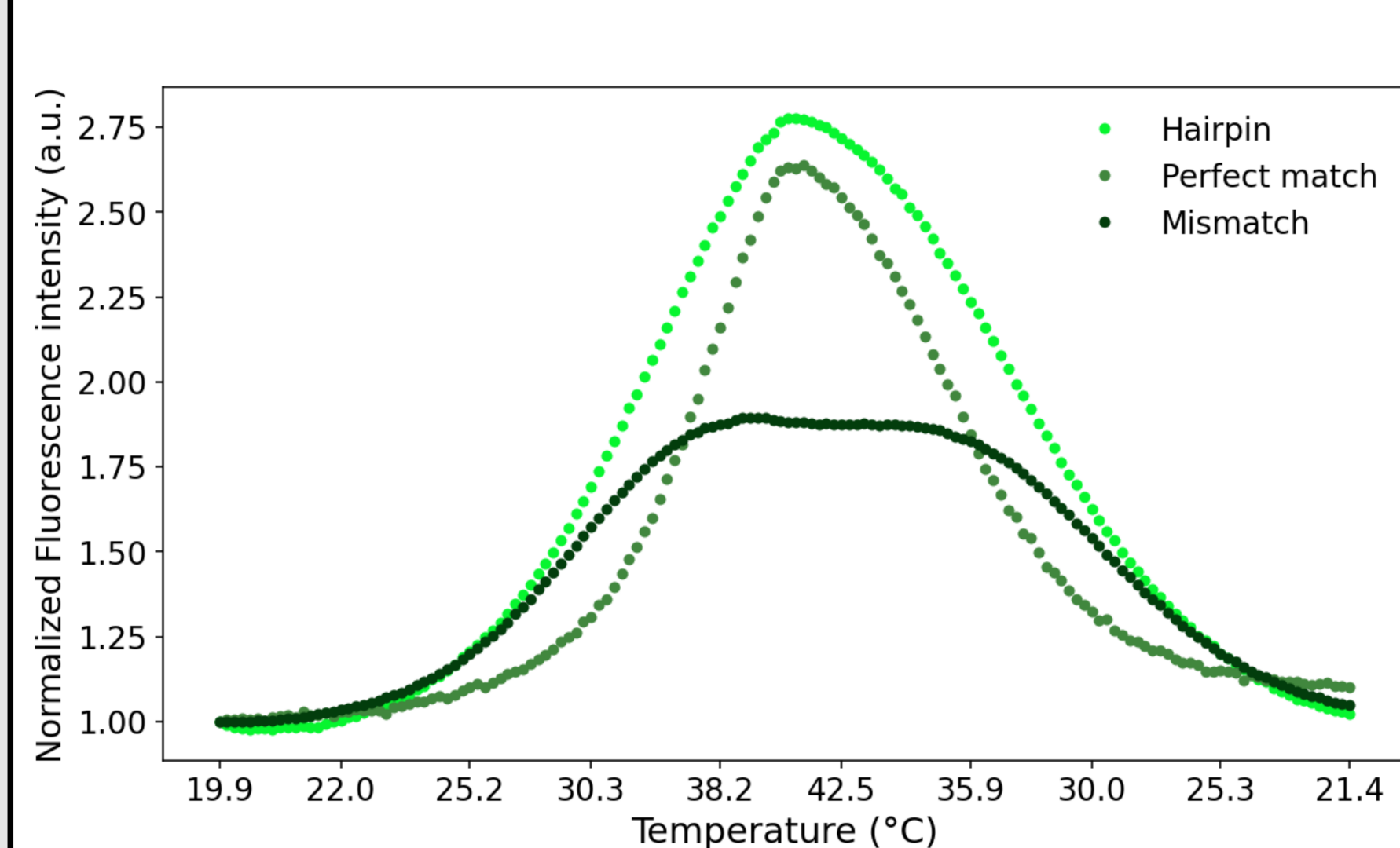
Schematic overview of phase shift extraction

Cut-off frequency (F_c) extraction

 -45° phase difference

Calculate relaxation time: $\tau = \frac{1}{2\pi F_c}$

MELTING CURVE ANALYSIS



Melting curve comparison of DNA samples

- The hairpin shows the steepest and most reversible response, confirming rapid equilibration
- Perfect-match duplex melts sharply at higher temperature
- Single-base mismatches melts at lower temperature with a broader, less intense transition

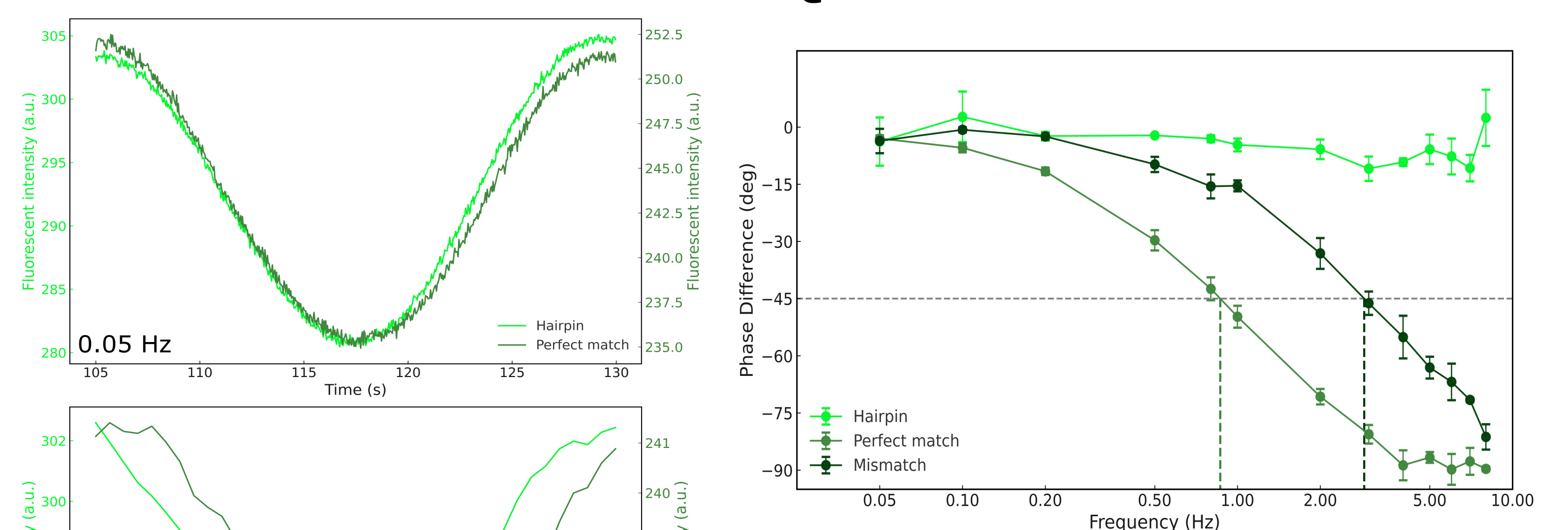
The PCB heater platform enables precise and rapid thermal profiles

CONCLUSION

- The microfluidic platform enables rapid and precise temperature control
- Supports sensitive, real-time fluorescence measurements
- Can quantitatively distinguish between perfectly matched and mismatched duplexes
- Adaptable for studying other temperature-dependent biological reactions

Offers potential to advance biomolecular kinetic studies with precise thermal control

FREQUENCY DOMAIN ANALYSIS



Bode plot of multiple discrete frequencies (0-8 Hz)

Temperature reportern shows no phase difference

Control experiment

DNA duplex samples do show clear increasing phase shift with increasing frequency

▼
Calculate cut-off frequency

Raw fluorescent signals of two distinct frequencies

- No phase difference is visible at lower frequency
- Phase shift visible at high frequency

Construct	Cutoff frequency (Hz)	Relaxation time τ (s)
Perfect-match duplex	0.87	0.182
Mismatch duplex	2.95	0.054

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