

Characterizing Cellular Response to Nanoscale Topographical Features

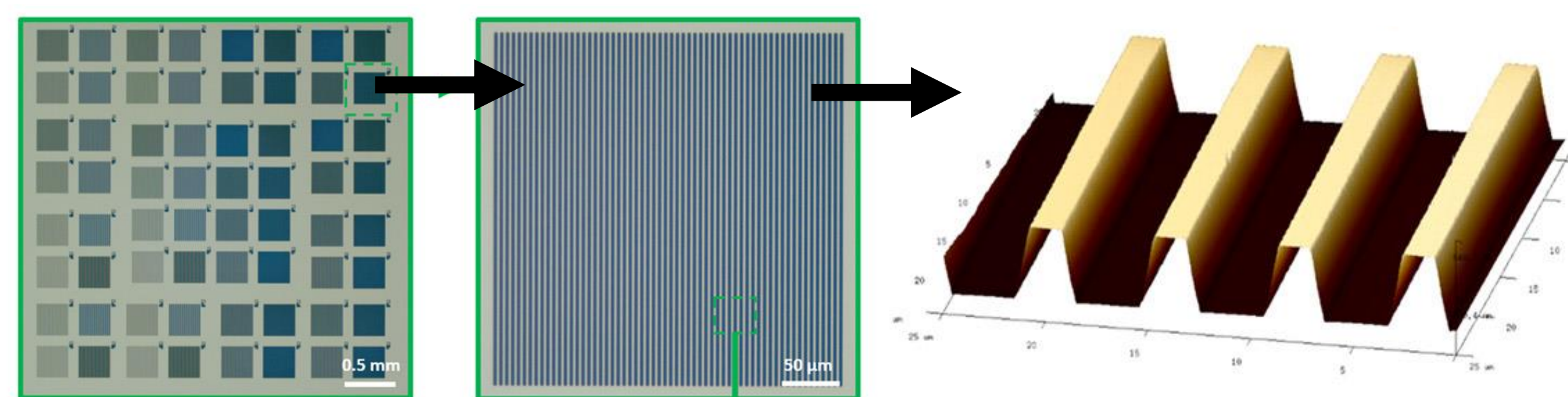
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Objective

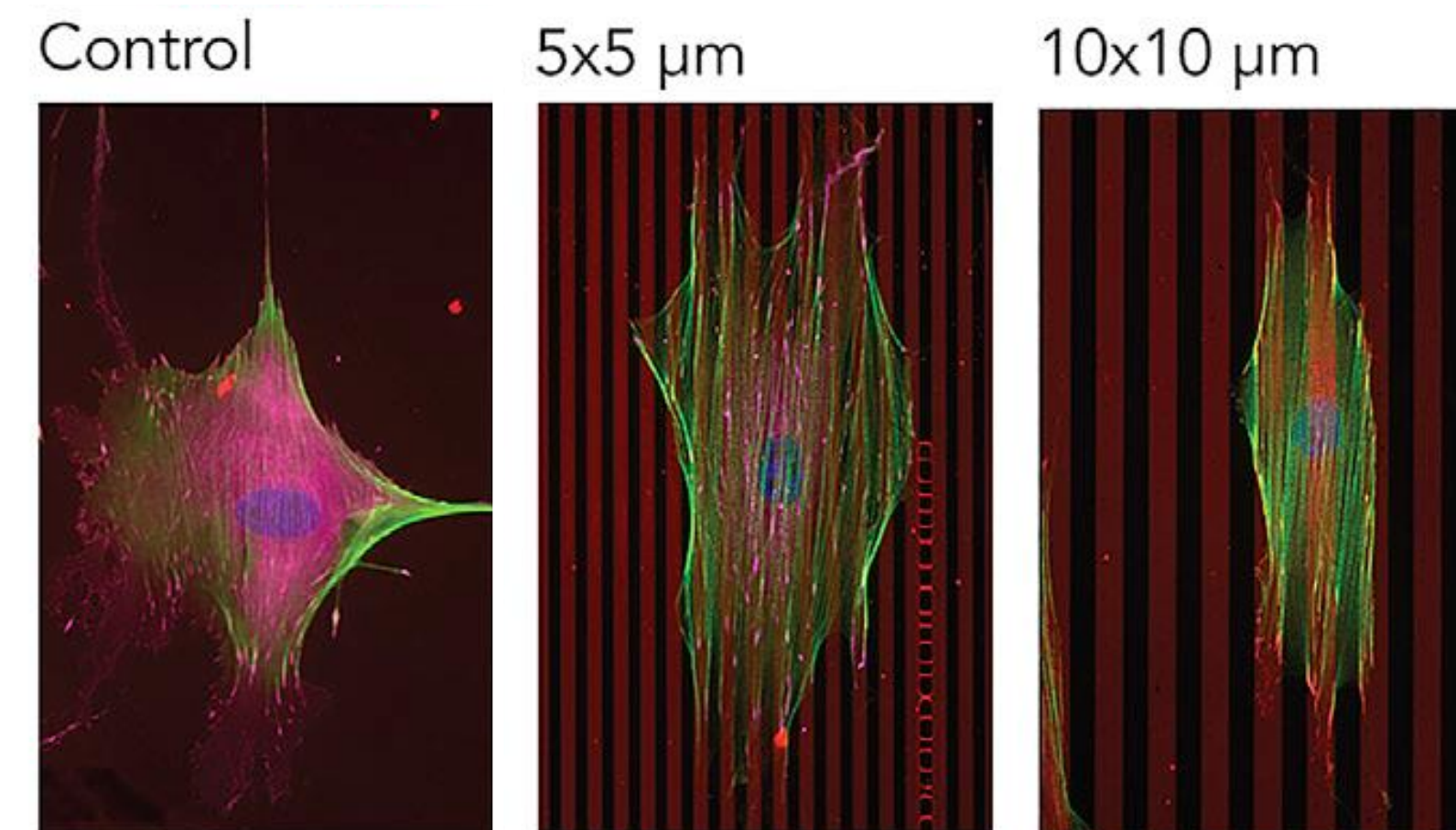
Analyze the dynamic response of cells to various grooved substrates of differing depths to characterize cell behavior and validate a standardized testing platform.

Motivation

- The phenomenon of cells orienting themselves relative to topographical features is known as **contact guidance**.
- While contact guidance is generally recognized as significant, difference in materials and methods across studies makes it difficult to determine general trends in metadata.
- A micro/nanotechnology-based biotool called a monolithic quartz contact guidance chip aims to provide a **standardized multiplexed testing platform for contact guidance studies**.



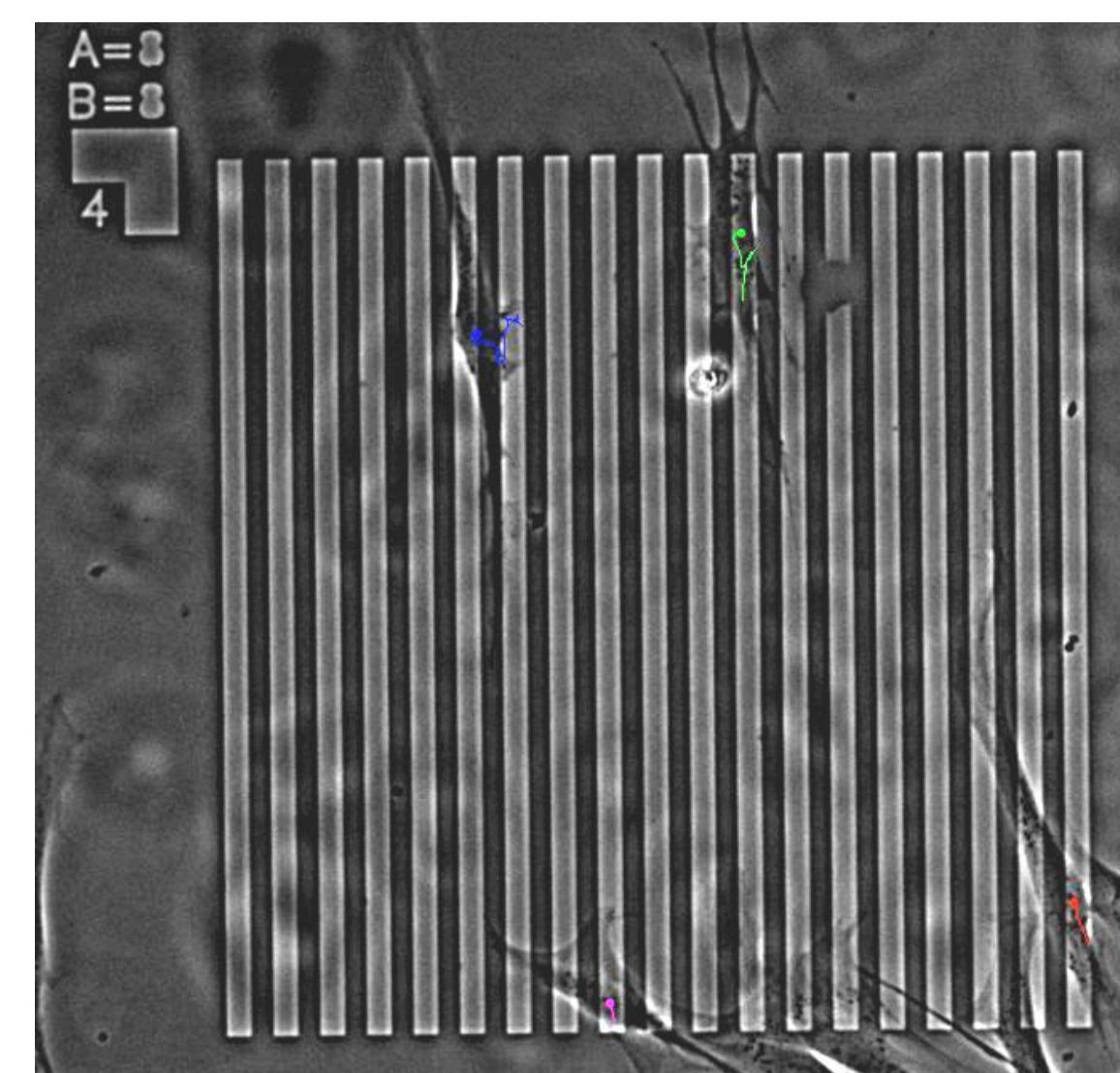
Multiplexed Contact Guidance Chip Detail [2]



Cell Orientation on Control vs Grooved Substrate [1]

Methodology

- Analysis was conducted on previously collected data due to COVID-19 limitations
- ImageJ was utilized to **manually track individual cell movement** over time
- Sensitivity to cell staining and imaging of topography prevented process automation



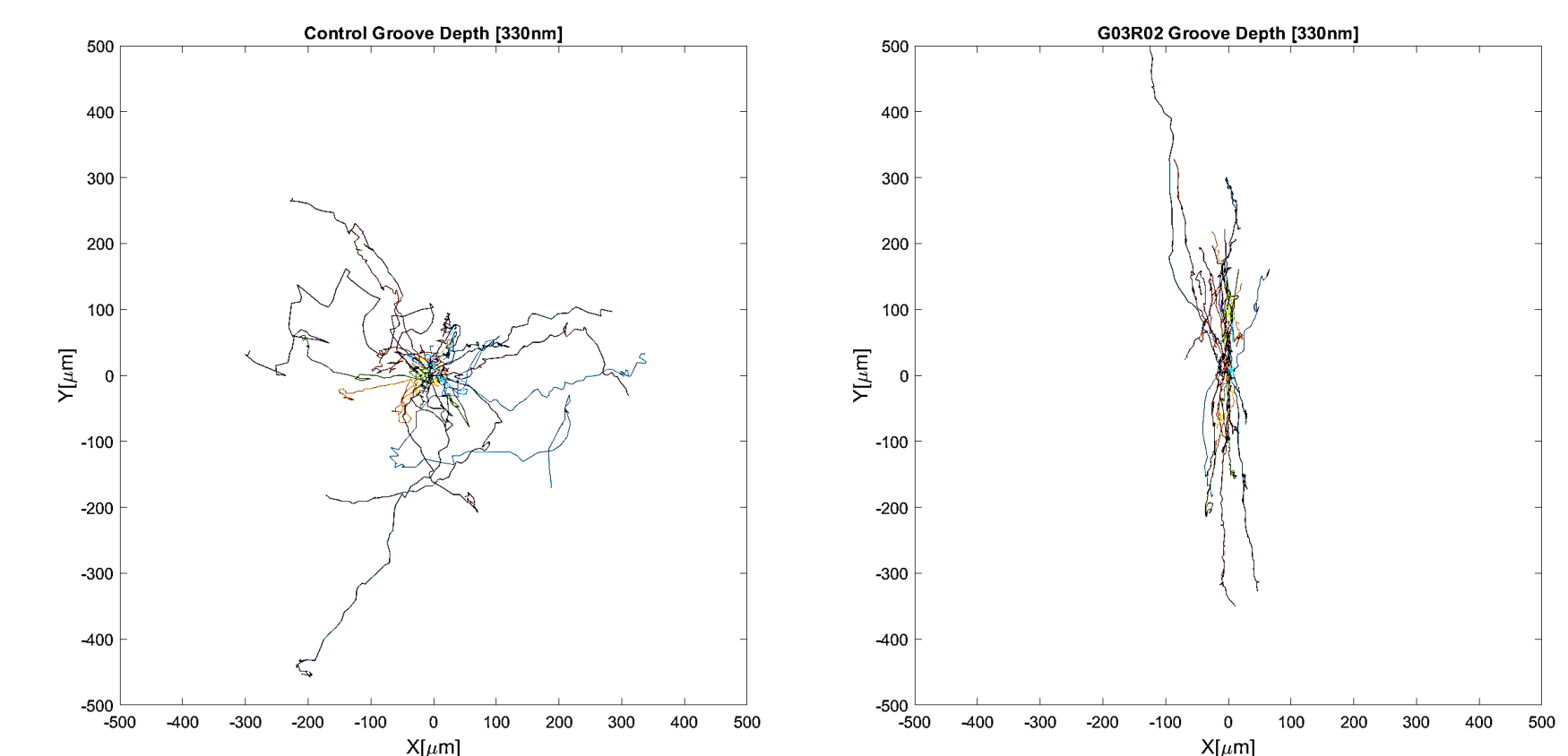
Dynamic Tracking on Quartz Chip [3]

Expected Analysis

Compare dynamic behavior of cells at differing ridge, groove, and depth topographies by characterizing:

- Total distance
- Cell velocity
- Cell directionality
- Trajectory orientation index (TOI)

$$TOI = \frac{\tan^{-1} \left(\frac{\sum_i |y_i|}{\sum_i |x_i|} \right) [deg]}{45} - 1$$



Cell Movement Tracks on Control vs Grooved Substrate [3]

Future Work

- Complete manual tracking of 725nm and 1000nm depth chips, analyze aggregate data to identify overall trends in cell behavior.
- Identify any concerns or feedback about use of the contact guidance chip gathered throughout data processing and analysis.

References

- [1] Buskermolen, A. B. C., Ristori, T., Mostert, D., van Turnhout, M. C., Shishvan, S. S., Loerakker, S., Kurniawan, N. A., Deshpande, V. S., & Bouten, C. V. C. (2020). Cellular Contact Guidance Emerges from Gap Avoidance. *Cell Reports Physical Science*, 1(5), 100055. <https://doi.org/10.1016/j.xcrp.2020.100055>
- [2] Robitaille, M. C., Christodoulides, J. A., Liu, J. L., Kang, W., Byers, J. M., Doctor, K., Kozak, D., & Raphael, M. P. (2020). Monolithic quartz platform for cellular contact guidance. *MRS Communications*, 10(2), 242–251. <https://doi.org/10.1557/mrc.2020.15>
- [3] M. Robitaille, C. Kim, J. Christodoulides, Y. Ng, W. Kang and M. Raphael. Hs27 Fibroblast Response to Contact Guidance Cues, (Journal manuscript in progress)