A highly reproducible and precise measurement platform for a 3D engineered cardiac muscle tissue contractility

Svetlana Pasteuning[1] (svetlana.pasteuning@optics11life.com), Tom Berkers[1], Giulia Pilia[1], Elizaveta Loseva[1], Thorsten Jonas[1], Stuart Prime[2], Jamie Bhagwan[2], Eliano dos Santos[3], Katarzyna Kmiotek-Caller[3], Ravi A. Kumar[3], Anna Zoccarato[3]

1 Optics11 Life, Amsterdam, The Netherlands
2 Axol Bioscience Ltd., Cambridge, United Kingdom
3 School of Cardiovascular & Metabolic Medicine and Science, King's College London, British Heart Foundation Centre of Excellence, United Kingdom

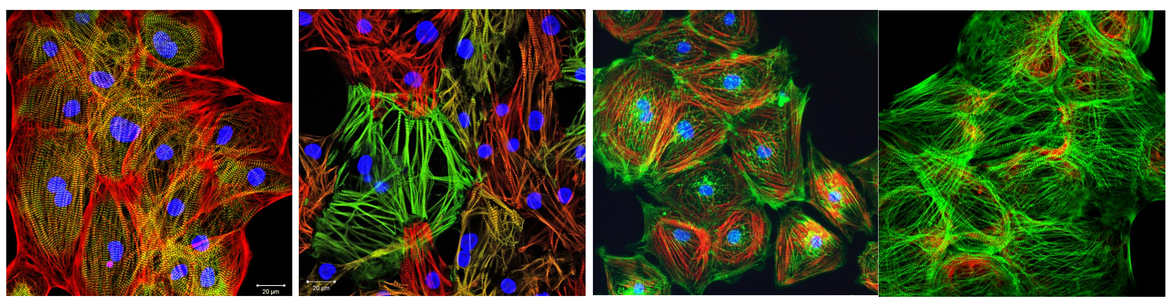
Abstract/Introduction

3D Engineered Heart Tissue Contractility Platform

Developing predictive and human-relevant cardiac models that balance accuracy and scalability is a significant challenge in preclinical drug development. Engineered heart tissues (EHTs) can fill this gap but often face issues with reproducibility and throughput. We introduce Cuore, a multi-well contractility platform from Optics11 Life. It allows standardized generation, pacing, and real-time force measurement of 3D cardiac tissues with nanonewton precision through optical interferometry. Using human iPSC-derived ventricular cardiomyocytes from Axol Bioscience and primary cardiac fibroblasts, we created a reliable, validated-on-Cuore EHT kit. These tissues showed stable maturation and functionality for up to 42 days. Pharmacological testing confirmed strong, reproducible inotropic responses, indicating sensitivity to drug-induced functional changes.

axoCells™ ventricular cardiomyocytes

2D cultures stained for key markers and displaying morphological hallmarks, including sarcomere alignment.

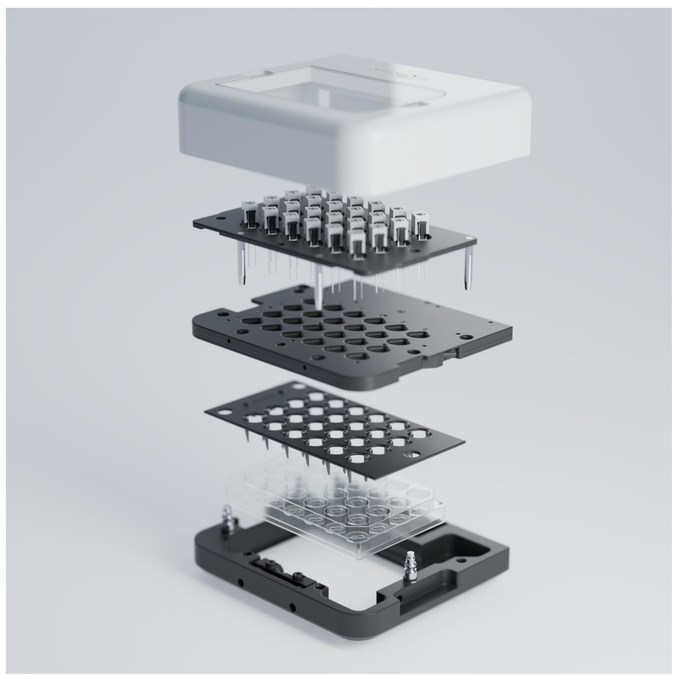


Actin/Myomesin/DAPI | MLC2V/MLC2A/DAPI | Cardiac Troponin T/ Cardiac Alpha Actinin/DAPI | Vimentin/Cardiac Troponin T

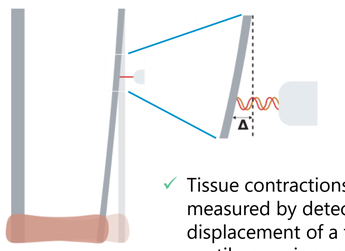
➢ Immunocytochemistry of axoCells™ ventricular cardiomyocytes stained for key markers
✓ Key morphological features are demonstrated, including the sarcomere alignment
✓ Magnification 63x for images 1,2 and 4; 40x for image 3. Scale bar = 20 µm.

Optics11 Life's technology

Cuore platform is designed to integrate long-term culturing of 3D engineered muscle tissue with its electrical stimulation and contractility measurements, enabling a broad range of assays.

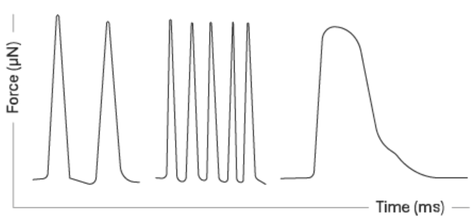


➢ Autoclavable & reusable
➢ Absolute force readout with nN and ms precision



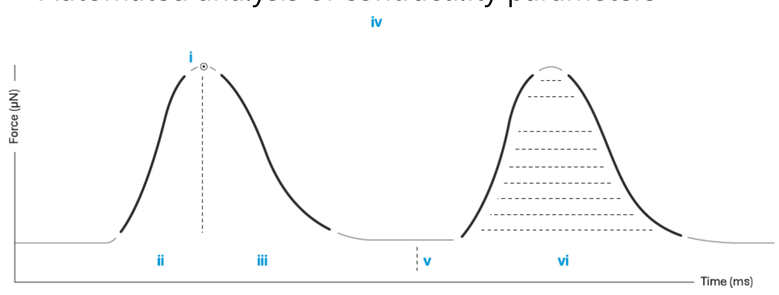
✓ Tissue contractions are measured by detecting the displacement of a flexible cantilever using an optical fiber sensor.

➢ Integration of electrical stimulation:



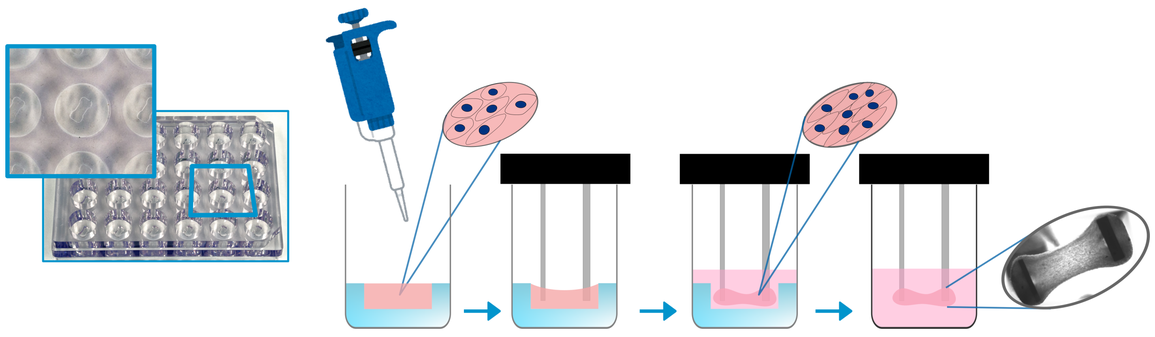
✓ Twitch
✓ Tetanus
✓ Exercise
✓ Fatigue
✓ Force-frequency response

➢ Automated analysis of contractility parameters



i. Maximum force
ii. Contraction time
iii. Relaxation time
iv. Frequency/Period
v. Tension build-up
vi. Pick width at all peak heights

➢ 24-well casting mold facilitates tissue formation

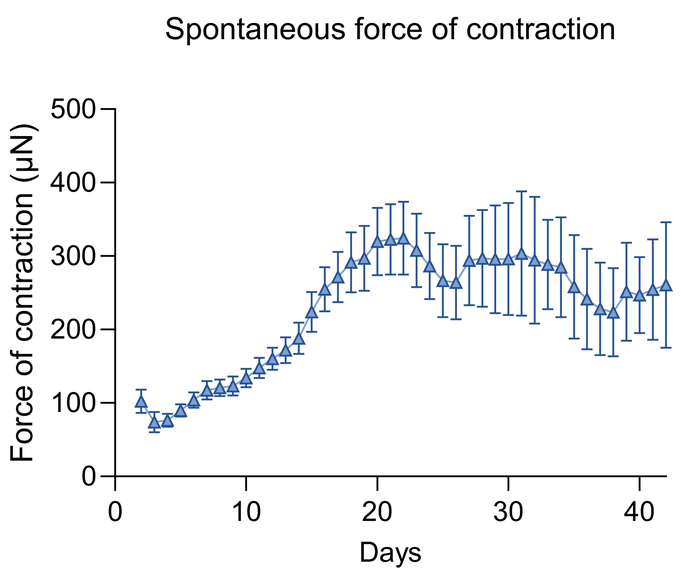


✓ Cast cells embedded in hydrogel into the 24-well plate mold (*left*) and insert the cantilevers in the mixture. Cells and matrix compact around the cantilevers into a 3D tissue that can be transferred to a standard 24-well plate (*right*)

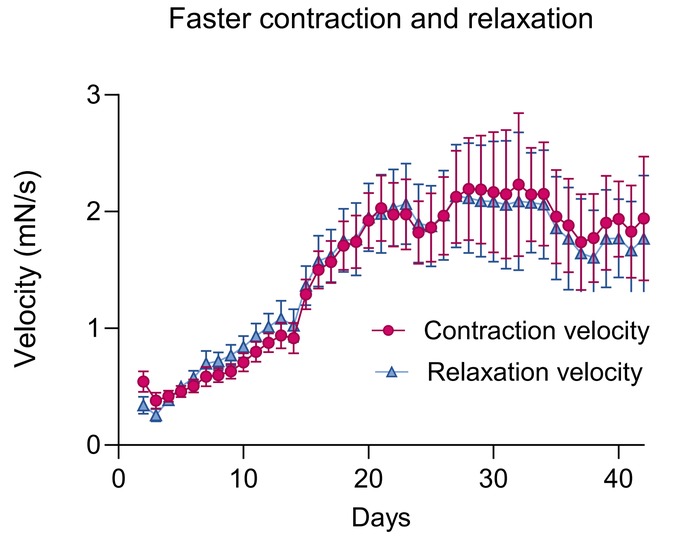
➢ Transparent bottom allows combining contractility measurements with imaging
➢ Tissues can be harvested for downstream biochemical and molecular analyses

EHT maturation increases force and speed

Cuore enables long-term measurement of force development



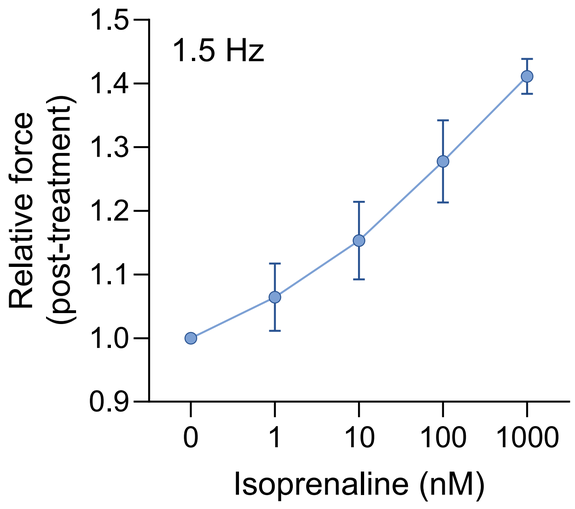
➢ **Absolute Force vs Time/Maturation**
✓ The longevity and maturation of 3D EHTs over 42 days (n = 24), Error bars indicate standard deviation.
✓ Tissue maturation is evidenced by increased spontaneous contractile force.
✓ Cuore enables long-term contractility measurements.



➢ **Contraction/Relaxation velocity vs Time/Maturation**
✓ The longevity and maturation of 3D EHTs over 42 days (n = 24). Error bars indicate standard deviation.
✓ Velocity calculated as V= $\frac{F_{80\%}-F_{20\%}}{t_{80\%}-t_{20\%}}$
✓ Tissue maturation is evidenced by increased contraction velocity (red) and relaxation velocity (blue).

EHTs respond to drugs

Cuore measures drug-induced functional modulations



➢ **Isoprenaline challenge** conducted under 1.5 Hz paced conditions resulted in a dose-dependent increase in force of contraction

Conclusion

Optics11 Life, in partnership with Axol Bioscience, has developed a plug-and-play solution for the long-term assessment of engineered cardiac tissues. This platform integrates Axol's axoCells™ ventricular cardiomyocytes with the Optics11 Life Cuore contractility system and includes a standardized workflow for creating and analyzing 3D engineered heart tissues. The solution enables reliable data collection on contractility, tissue morphology, and pharmacological responses, streamlining workflows to support more accurate drug development decisions. Additionally, it promotes enhanced tissue maturation and consistent performance over time, making it a valuable tool for predictive drug safety and efficacy screening in cardiac research.

References

• A. Iuliano et.al., Sensing. Adv. Mater. Technol. 2023, 8, 2300845. https://doi.org/10.1002/admt.202300845
• Vinarsky, V et.al., *Cell Death Discov.* **11**, 518 (2025). https://doi.org/10.1038/s41420-025-02793-2
• Ralu M et.al., Mol Ther. 2026 Mar 24:S1525-0016(26)00211-X. https://doi: 10.1016/j.ymthe.2026.03.025

www.axolbio.com | operations@axolbio.com
www.optics11life.com | saleslifescience@optics11life.com