Jury report
Philips Graduation Award for Biomedical Engineering 2018

N.M.E. (Nicolás) Mateos Estévez MSc (Universiteit Twente)
Photonic emitter manipulation to achieve axial super-resolution for in vivo cell membrane topography studies

The candidate has demonstrated a consistently excellent academic track record, earning a B.Sc. in Physics Engineering from the Universitat Politecnica de Catalunya, and a M.Sc. *cum laude* in Biomedical Engineering from the University of Twente. He was a research summer fellow, and performed his bachelor thesis work, at the renowned Institute of Photonic Sciences (ICFO) in Barcelona, leading to a publication in the American Journal of Physics. He has received scholarships from the Catalan Joves I Ciencia programme, ICFO, and the University of Twente.

The cell membrane is a fascinating and exceedingly complex biological membrane composed largely of lipids and proteins, and is implicated in several aspects of cellular shape and function. The cell membrane exhibits topographic variation at the nanometer scale; these variations likely play a role in membrane function. Visualizing these nanoscale variations in membrane topography is hampered by the lack of (axial) resolution of commonly used optical microscopy approaches. Scanning probe microscopy alternatives lead to deformation of the soft membrane surfaces, thus interfering with the measurement. Electron microscopy achieves the necessary axial resolution, but requires fixation of the cellular sample.

This thesis presents the implementation of an innovative approach to achieve axial super-resolution without directly interacting with the membrane (or for that matter, any) surface based on the principle of modification of the emission rates of fluorophores using a photonic emitter (or Local Density of Optical States) manipulation probe developed in the host laboratory. Using a sensitive confocal microscopy setup with single molecule sensitivity and a mirror mounted on an atomic force microscopy microcantilever as emitter manipulation probe, the candidate has been able to demonstrate <20 nm height differences with relatively low numbers of collected photons (that is, with very reasonable image collection times).

The jury was impressed with the quality of the work presented in this thesis, and by the structure, clarity, and readability of the document. The thesis describes the theoretical background and the instrumentation, and then successively demonstrates the use of the emitter manipulation probe with a series of samples of increasing complexity, beginning with fluorophores embedded in thin polymer films, nanofabricated structures (polymers, and etched gratings), and supported lipid bilayers. Finally, the thesis presents first measurements on fixed cells.

Based on the excellent content of the thesis, the clarity of presentation, and his outstanding academic track record, the jury is convinced that Nicolás Mateos is a worthy winner of the Philips Afstudeerprijs voor Biomedische Technologie.

Prof. dr. N. (Niels) Geijsen, hoogleraar regeneratieve geneeskunde Universiteit Utrecht, senior groepsleider KNAW-Hubrecht Institute, Founder en Scientific Advisor NTrans Technologies B.V.
Prof. dr. V. (Vinod) Subramaniam, rector magnificus Vrije Universiteit

De jury vergaderde op 17 oktober 2018 onder leiding van Drs. J.J.Q. Lampe, directeur KHMW. Tevens waren ter vergadering aanwezig Prof. dr. A.P. IJzerman, secretaris natuurwetenschappen en Drs. S. van Manen, secretaris.