

Simulation of daily soft multifocal contact lenses using SimVis Gekko: from in-vitro and computational characterization to clinical validation



Eduardo Esteban-Ibañez^{1,2}

Carlos Dorransoro^{1,2} and Enrique Gamba²

1. Institute of Optics, Spanish National Research Council (IO-CSIC); Madrid, Spain
2. 2EyesVision SL, Madrid, Spain



BACKGROUND

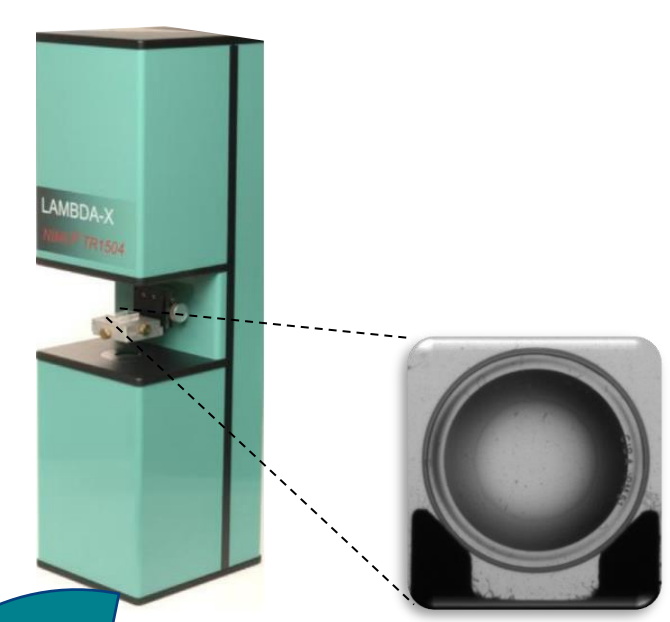
The SimVis Gekko visual simulator (2EyesVision SL, Spain), based on temporal multiplexing [1], has already demonstrated its ability to simulate multifocal intraocular lens designs using data from the public literature [2]. Having the opportunity of experiencing any commercial Multifocal Contact Lenses (MCLs) through SimVis Gekko simulations, aids patients in visualizing their potential vision with different designs, facilitating the recommendation of the most suitable option and enhancing the overall adaptation process.

PURPOSE

Our main objective in this study was to obtain accurate SimVis Gekko simulations of different daily commercial soft MCL designs from four manufacturers based on in-vitro and computational characterizations. The accuracy of these simulations was clinically validated comparing them with the same designs of real MCLs in a small group of presbyopes.

METHODS

Nimo TR-1504 and MCLs measured in-vitro



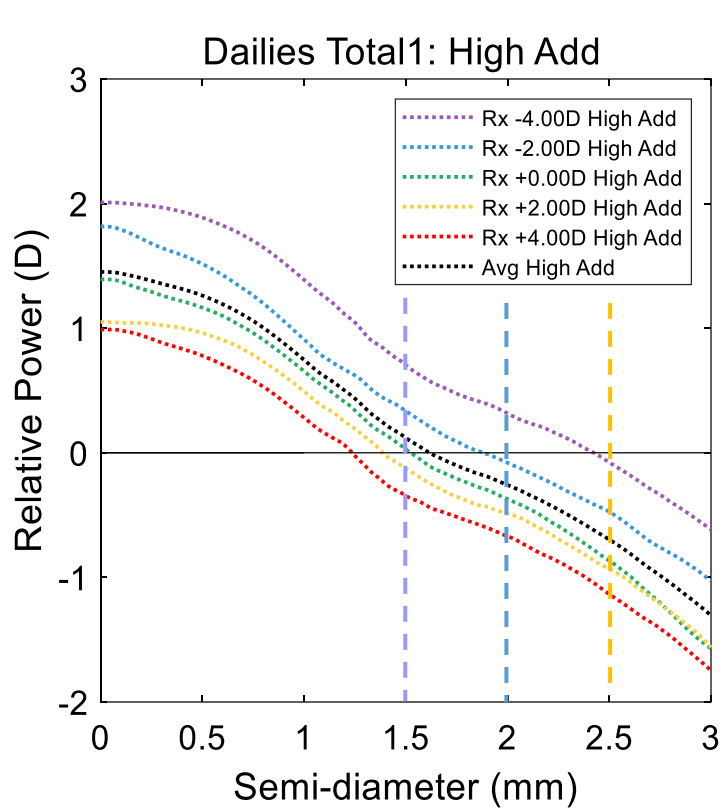
Commercial instrument based on: Phase-shifting Schlieren principle [3]

- 4 commercial families:
 - Dailies Total1
 - MyDay
 - Acuvue Moist
 - Biotrue ONEday
- Up to three additions
- Up to five nominal powers
- Three repetitions

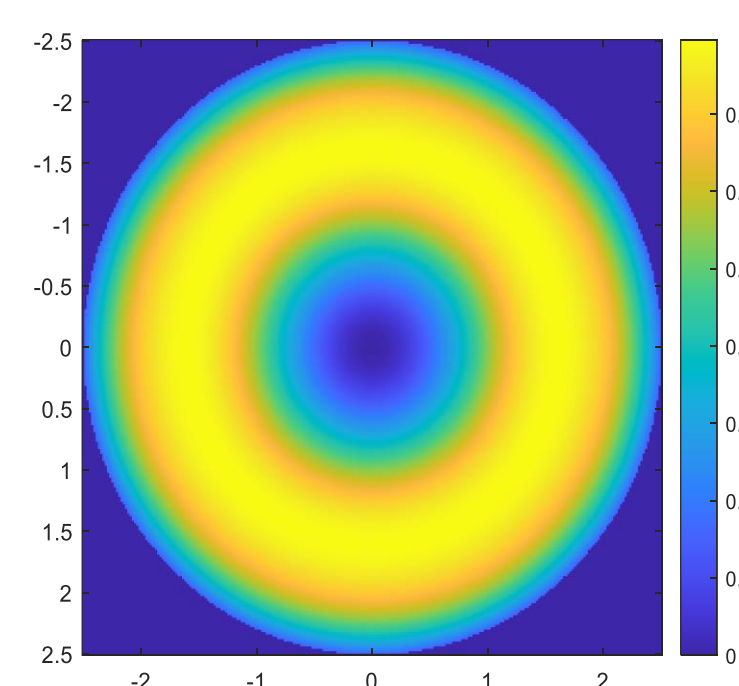
42 MCLs – 126 measurements

Computational process to obtain the Through Focus Visual Strehl (TF-VS)

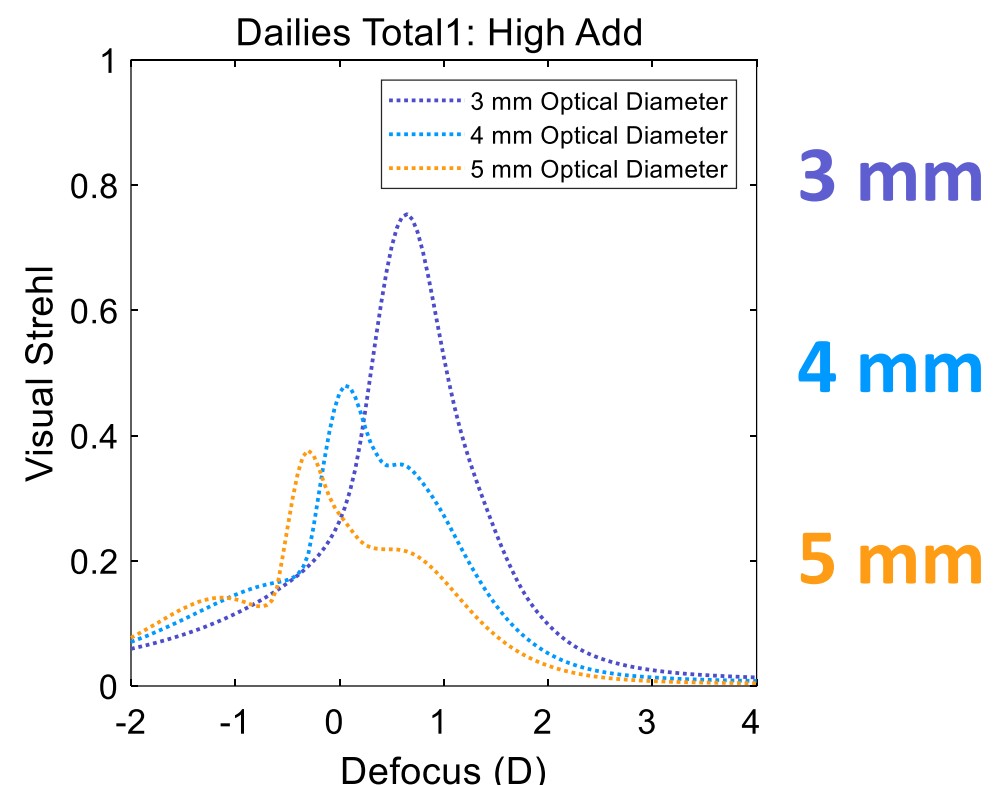
Relative Power Profile (RPP)



Phase Map

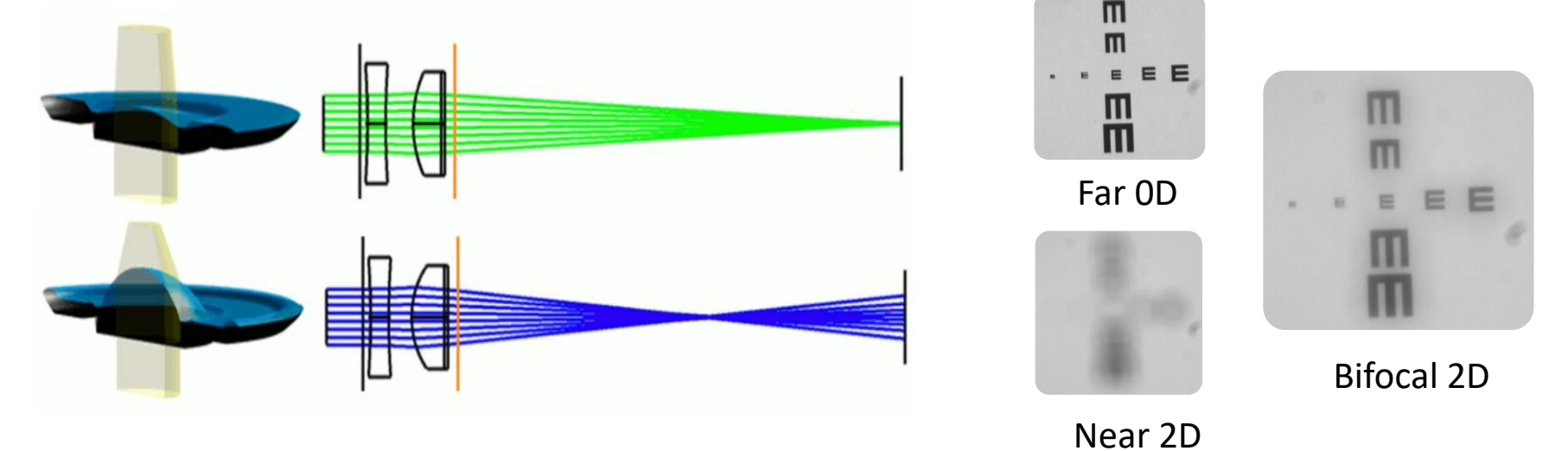


TF-VS for different optical diameters



Visual Simulator: SimVis Gekko

Wide field of view, Wearable, Programmable, See-Through Binocular, Rx corrected using trial lenses. SimVis Gekko simulates multifocal corrections using optunables lens working under temporal multiplexing:

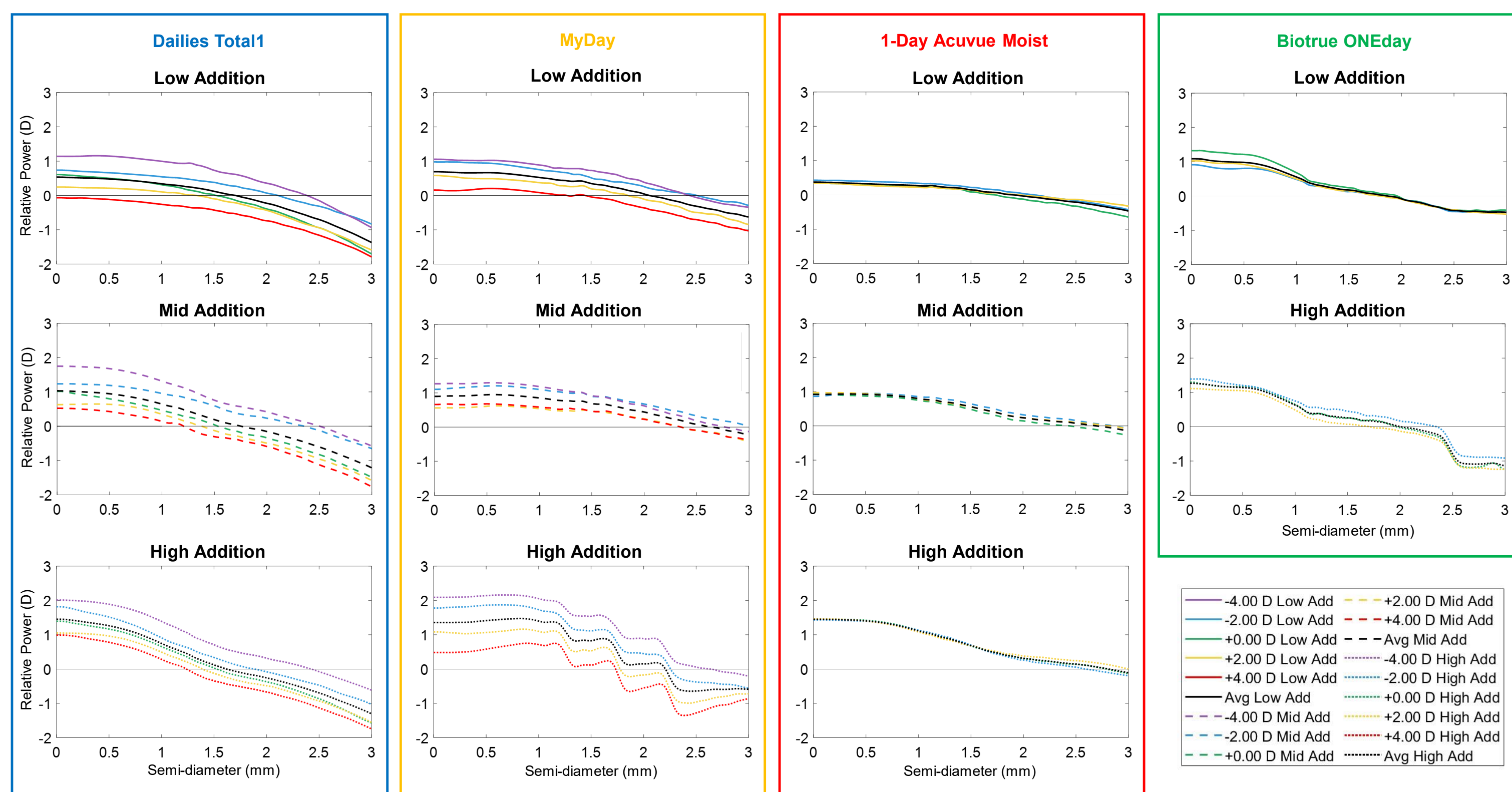


Clinical Validation of SimVis Gekko MCL simulations

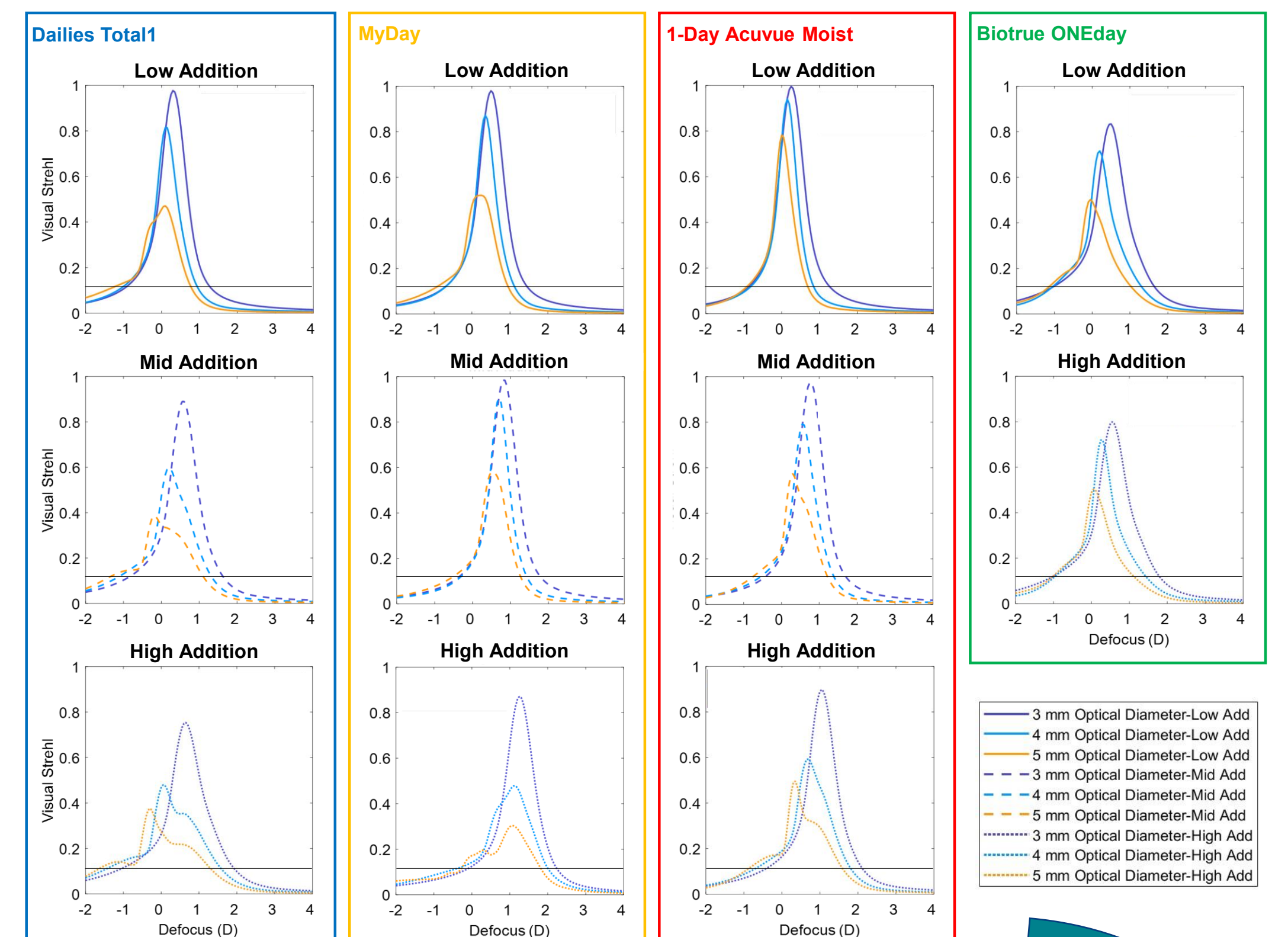
- 8 presbyopes: 4 myopes and 4 hyperopes
- Distributed in two groups: Low and High Addition
- Measurements:
 - Through-Focus Visual Acuity (TF-VA): from +1.00 to 4.00 D
 - VA at real distances: Far, Intermediate and Near (4, 0.66 and 0.4 m)

RESULTS

In-vitro characterization



Computational characterization



Clinical Validation of SimVis Gekko simulations: 3 families of MCLs



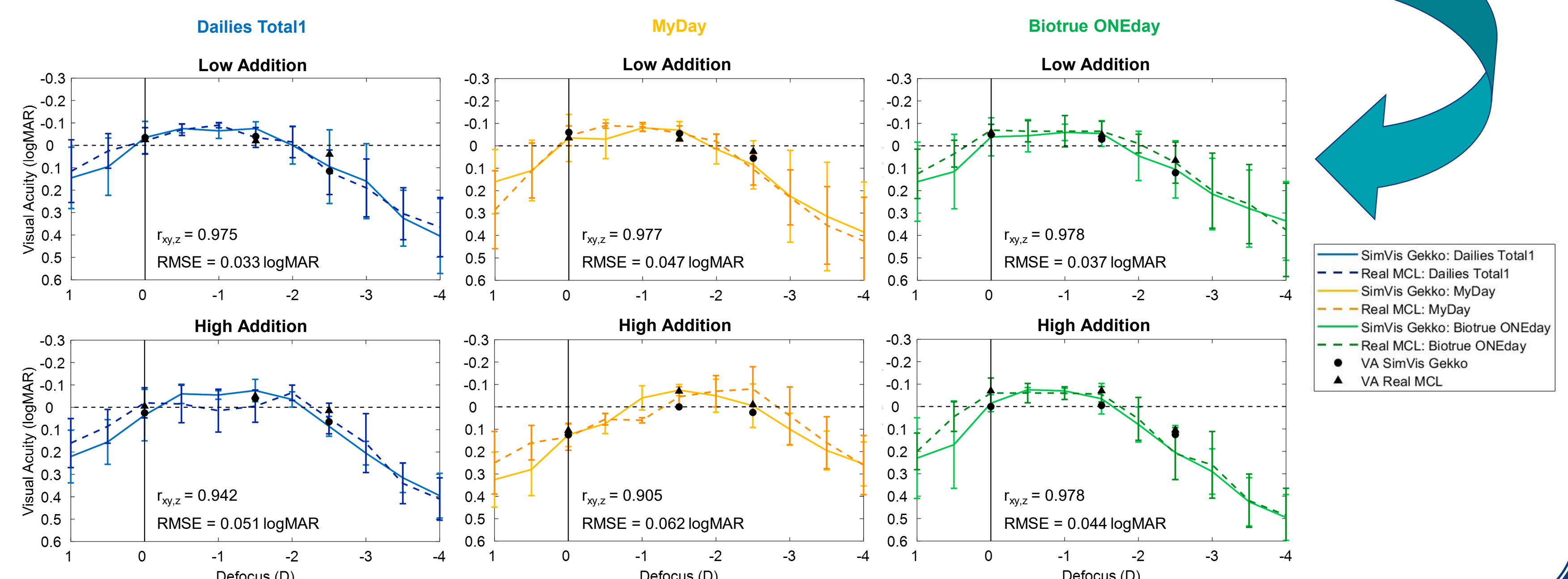
VS TF-VA

VA at real distances



SimVis Gekko simulations of the same MCLs

All MCL designs showed a partial correlation ($r_{xy,z}$) higher than 0.90 and a Root Mean Square Error (RMSE) below 0.07 logMAR between the TF-VA of SimVis Gekko simulations and Real MCLs across subjects.



CONCLUSIONS

- The computational characterization (TF-VS) of MCLs for different families, additions and optical diameters based on in-vitro measurements allows to obtain SimVis Gekko simulations.
- These SimVis Gekko MCL simulations capture the multifocal performance of real MCLs, demonstrating a high level of accuracy and excellent agreement between the simulated and real lens performance.

REFERENCES

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- Sawides, L. et al. SimVis simulations of multifocal IOL designs based on public-literature data. in Proc. SPIE vol. 11871 1187100 (2021).
- Joannes, L. et al. The reproducibility of a new power mapping instrument based on the phase shifting schlieren method for the measurement of spherical and toric contact lenses. Cont Lens Anterior Eye 33, 3–8 (2010).