

New set of complementary extended-depth-of-focus IOL: comparison with the state-of-the-art

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Purpose

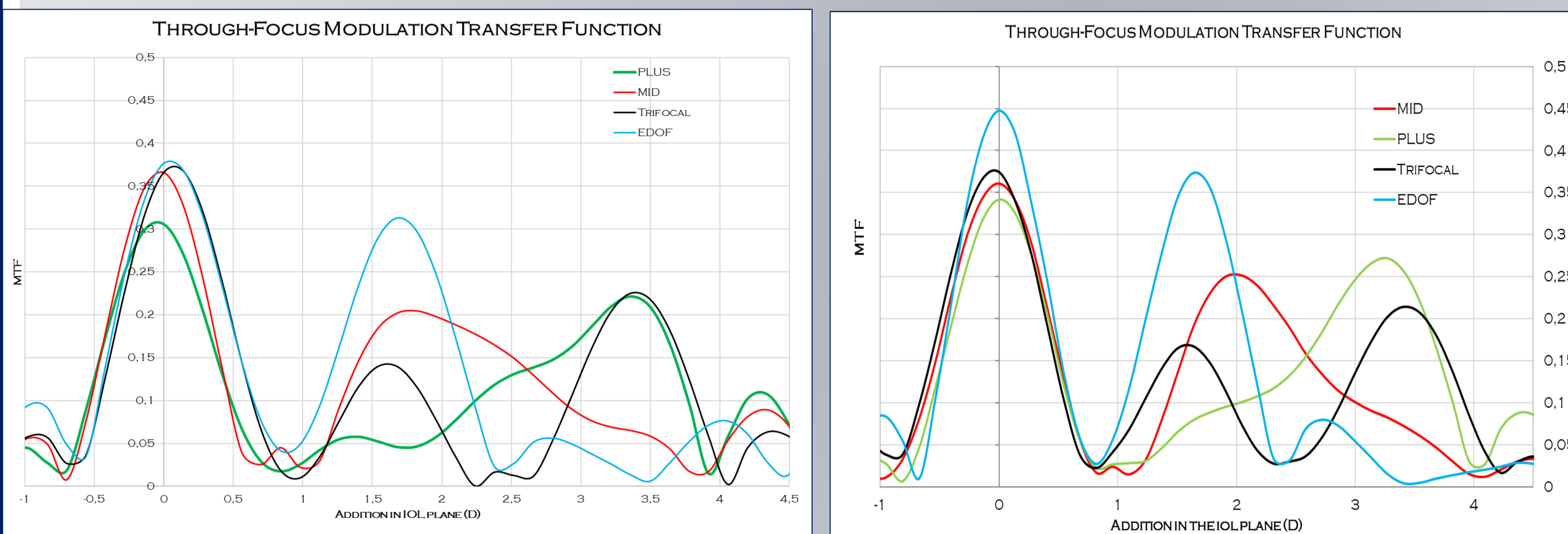
To compare the through-focus optical quality of two new complementary extended-depth-of-focus (EDOF) IOLs with a state-of-the-art trifocal and EDOF ones.

Material and Methods: Four IOLs are under study: two new diffractive IOLs one favoring intermediate range (MID) and the other favoring near vision range (PLUS) are two new diffractive complementary IOLs, with extended depth of focus that were designed to benefit from binocularity. They are compared with a trifocal IOL with +1.75D/+3.5D focal points and an extended-depth-of-focus IOL. The through-focus modulation transfer function (TF-MTFs) at 50 cycle/mm from +1D to -4D, are compared in silico and on optical bench. We applied the strong linear relationship between 1/MTFa (averaged TF-MTF) and clinical defocus curves demonstrated by Alarcon to four diffractive IOLs, to simulate the defocus curves with those 4 IOLs..

Results: We found good agreement between simulation and optical bench measurements. The four IOLs have similar peak heights for distance vision, with very little higher energy for the MID with respect to the PLUS IOL.

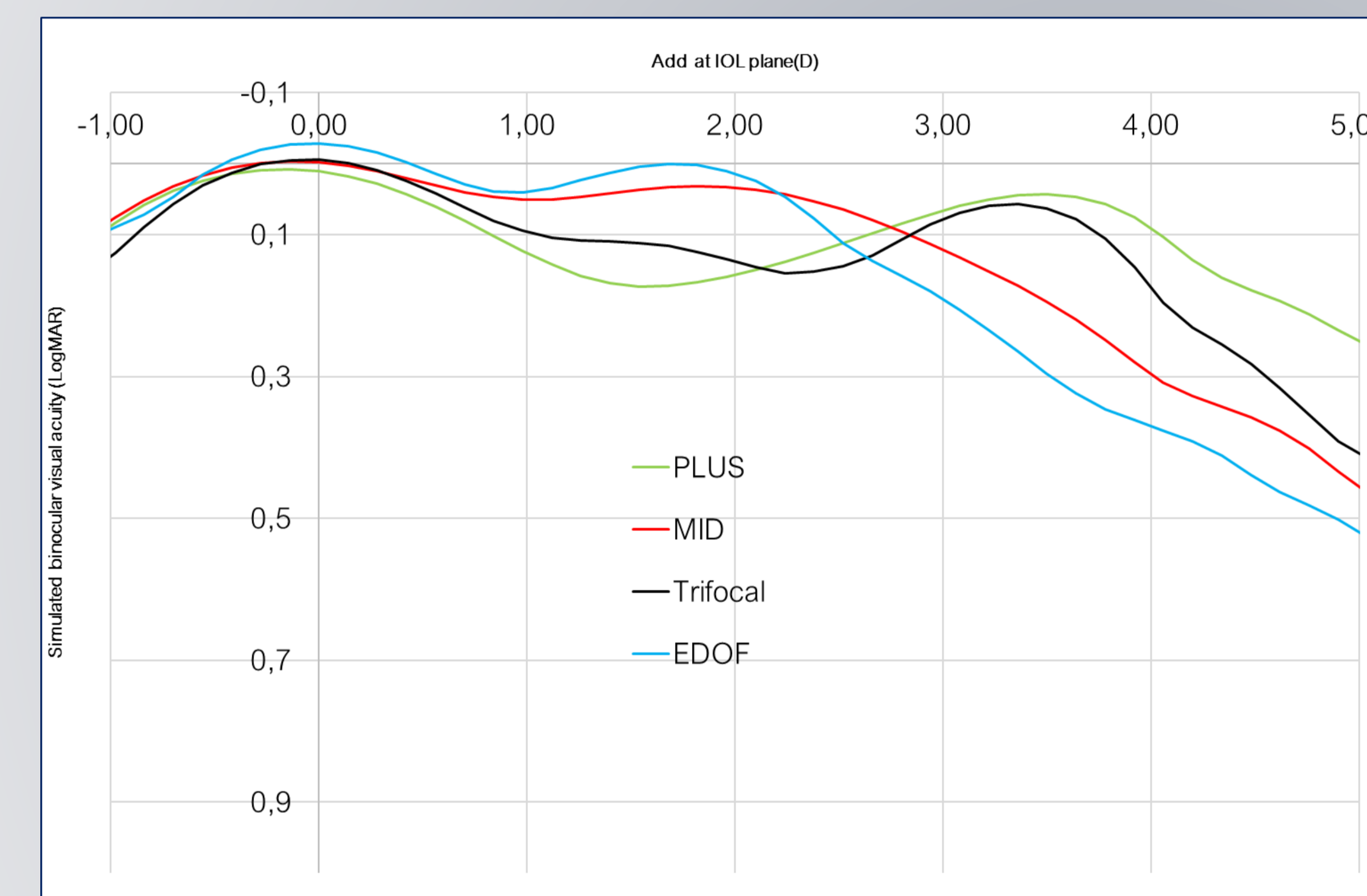
Through-focus Modulation Transfer function

Simulation (left)@ 3mm, 50 cycles/mm Optical bench (right)@ 3mm, 50 cycles/mm



The trifocal presented the well-known pattern with two other narrow peaks on TF-MTF at 1.75D and 3.5D, The EDOF had a bifocal through-focus MTF with 1.75D addition, while MID demonstrated a broad peak with a maximum on 1.8D, with height higher than 0.15 towards 2.5D and PLUS had a broad peak, with height higher than 0.15 from 2,5D to more than 3.5D.

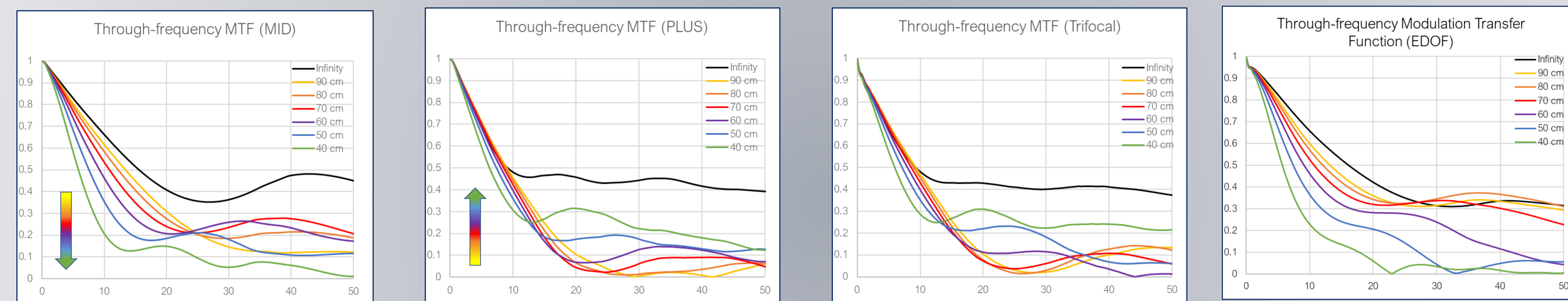
Simulated defocus curve using Alarcon*



MID and EDOF demonstrated better simulated visual acuity from -0.5D to 2D than Trifocal and PLUS. PLUS was higher than MID, trifocal and EDOF from 2D to 3D. Combination of MID and PLUS complementary IOLs should provide a continuum of simulated visual acuity higher than 0.10 from 0D to 4D (in the lenticular plane).

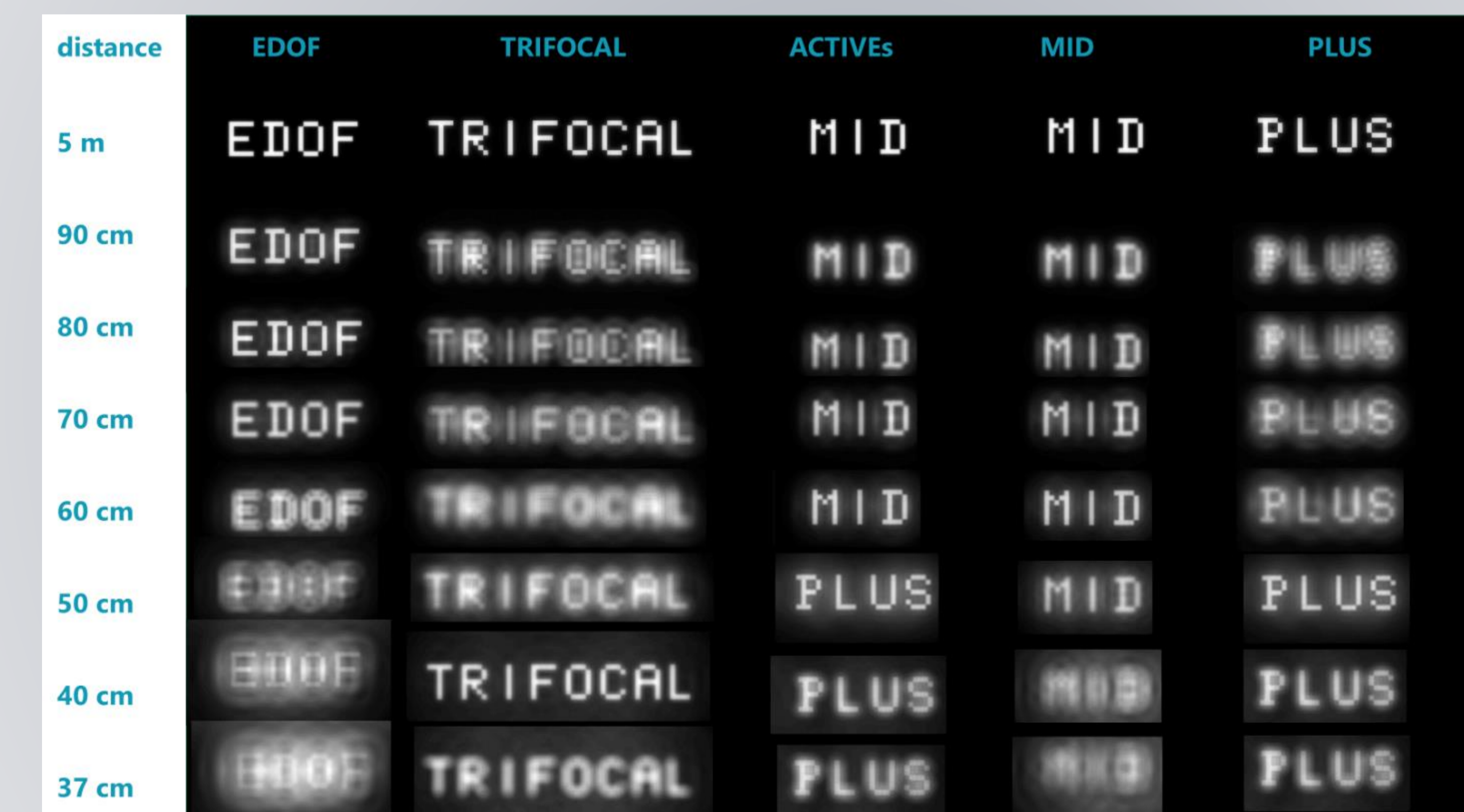
* Alarcon A, Canovas C, Rosen R, Weeber H, Tsai L, Hileman K, Piers P. Preclinical metrics to predict through-focus visual acuity for pseudophakic patients. Biomed Opt Express. 2016 Apr 15;7(5):1877-88.

Through-frequency (cycles/mm) MTF(Simulation)



It is interesting to note that the colors coding for the distance of vision of the frequential MTF are inverted (see arrows) between the MID and PLUS IOLs which reveals their complementarity. The Trifocal IOL displayed very little MTF between 20 and 30 cycles per mm in the intermediate range (90, 80 and 70 cm). The EDOF IOL displayed the same color continuity as the mid but EDOF has no near vision.

TF- Imaging (Simulation)



Conclusion: Although the TF-MTF is only relevant of the contrast, it is admitted that MTF higher than 0.15 is relevant of functional visual acuity. With complementary implantation of ARTIS ACTIVE MID and PLUS, patients should benefit of continuous sharp vision from infinity to 35 cm, with no need for adapting the object distance to the best focus, which would be a significant improvement to the state-of-the-art.