

Complementary binocular presbyopia-correcting IOL System

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IVCRC / DJ Apple Laboratory: Financial Disclosure 2025/2026

Afidera³
Alcon^{1,2,3,4}
AMO/Johnson&Johnson^{1,2,3,4}
Carl Zeiss Meditec^{1,2,3,4}
Contamac¹
Cristalens^{1,2,3,4}
Elios^{1,3,4}
Eyebright³
EyeD¹
Eyedeal¹
EyeYon^{1,2,4}
Fluoron¹
Hanita^{1,2,3,4}
Hoya^{1,2,3}
Kowa^{1,2,3}
Oculus^{1,3}
Presbia¹
Rayner^{1,2,3,4}
Teleon^{1,2,3}
1stQ¹



Klaus Tschira Stiftung
Gemeinnützige GmbH



1 = Research Grants; 2 = Travel Expenses; 3 = Lecture Fees; 4 = Consulting



Monofocal⁺/EDOF/Trifocal-IOLs



Teleon
Lentis/Acunex
Quantum



BVI/Physiol
Isopure



Santen Xact
Mono-EDoF IOL



Rayner
RayOne EMV



EVOLUX



Hoya
Vivinex
Impress



B & L
Akreos
Adapt AO

Monofocal⁺



J & J TECNIS
Symphony



J & J TECNIS
PureSee



Zeiss
AT Lara



IC-8/Aphera



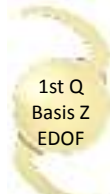
Lentis Comfort
MF15



AcrySof IQ
Vivity™



SAV – IOL SA
Lucidis



1st Q
Basis Z
EDOF



B & L
LuxSmart

EDoF-IOL



J & J TECNIS
Synergy



Zeiss
AT Lisa Tri



Zeiss
AT
Elana



Physiol/BVI
Triumf



VSY Acriva
Trinova



Rayner
Trifocal



AcrySof IQ
Panoptics



Hanita
Intensity



1st Q
Basis Z
Trifocal



Hoya
Vivinex
Gemetrics

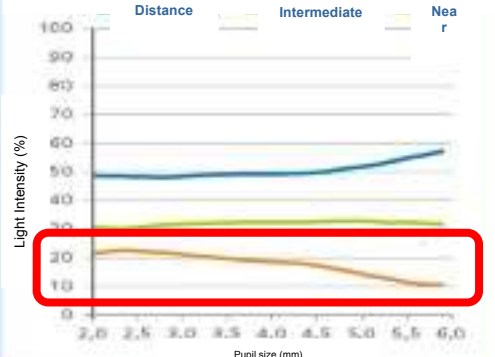
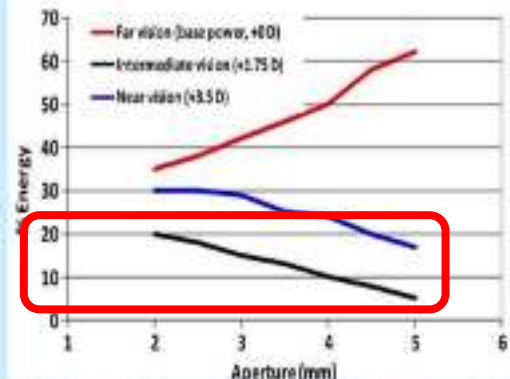


Cristalens
Artis Symbiose
Mid & Plus

Trifocal-IOL



Different Light Energy Distribution in Trifocal IOLs

AT LISA tri 839 MP (Zeiss)	FineVision (Physiol)
diffractive IOL Aberration correcting aspheric optic design Near addition +3.33 D Intermediate addition +1.66 D	apodized diffractive IOL Combination of two diffractive IOLs Intermediate addition: +1.75 D Near addition: +3.5 D
asymmetric light distribution of 50 %, 20 % and 30 % between distance-, intermediate- and nearfocus	9% of the light in an eye (4.5 mm pupil diameter) is used for intermediate distance
Higher pupil independence	Diffractive optic is pupil dependent → reduction of glare effects at night
Asymmetrical Light Distribution of AT LISA tri*  Source: Carl Zeiss Meditec AG, AT LISA tri 839MP: Die erste trifokale vorgeblendete true-MCS-IOL für echten Intermediarvision. 2011	 Guérin D, Fagnola C, Houbrecht Y, Gobin L. Design and qualification of a diffractive trifocal optical profile for intraocular lenses. J Cataract Refr Surg. 2011; 37:2080-2087



Photic Phenomena after MIOL Implantation

Material & Methods: Halo/Glare Simulator*



*Eyeland Design
Network GmbH,
Vreden, Germany



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg

Average Halo & Glare Performance (M)IOLs



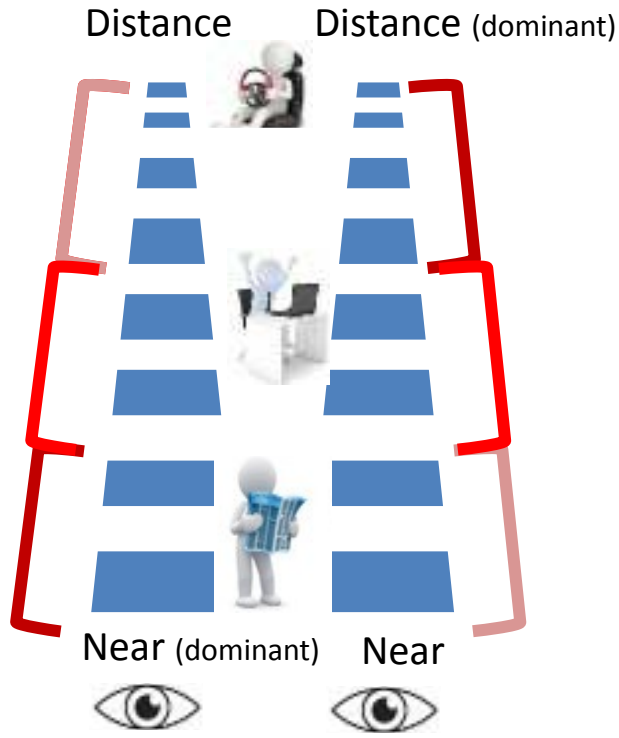
*Data on file: Int



Achieving binocular Trifocality



Achieving binocular Trifocality



Distance dominant eye :

Near dominant eye :

Binocular:

Distance + Intermediate + Near

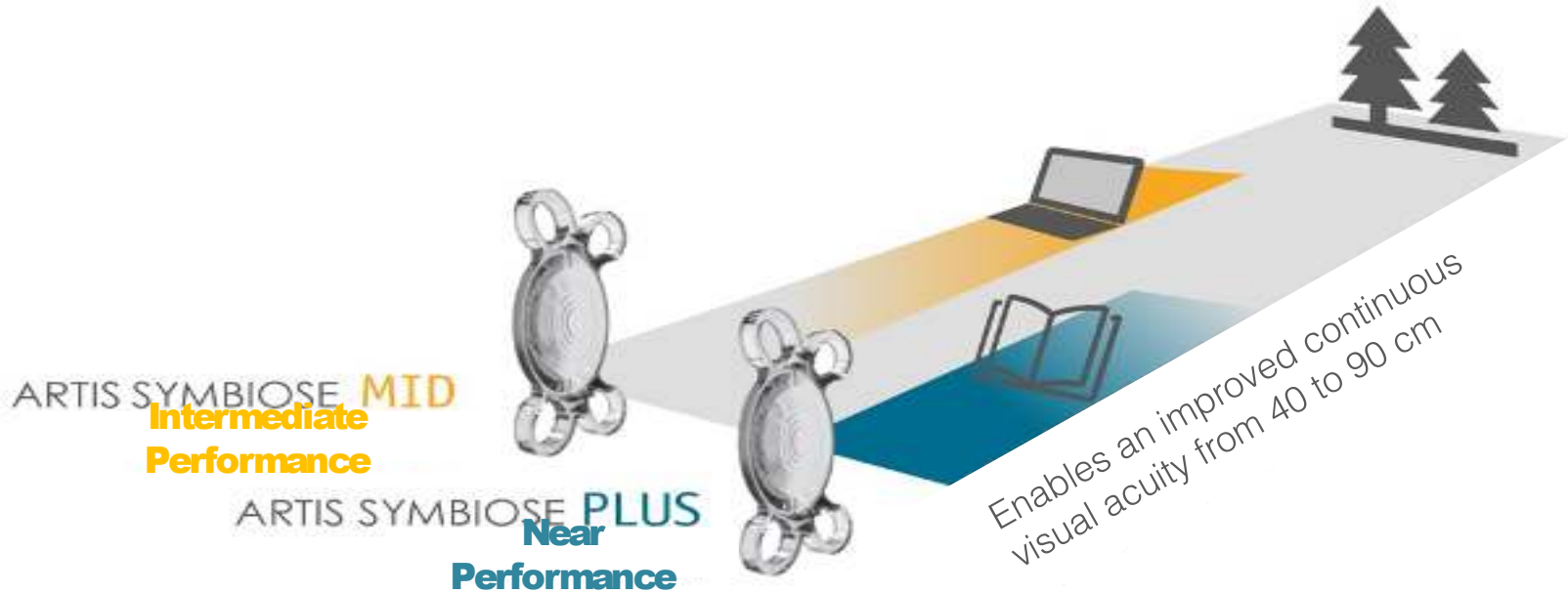
Distance + Intermediate + **Near**

Trifocality

Combination of :
Special trifocal optics:
Artis Symbiose

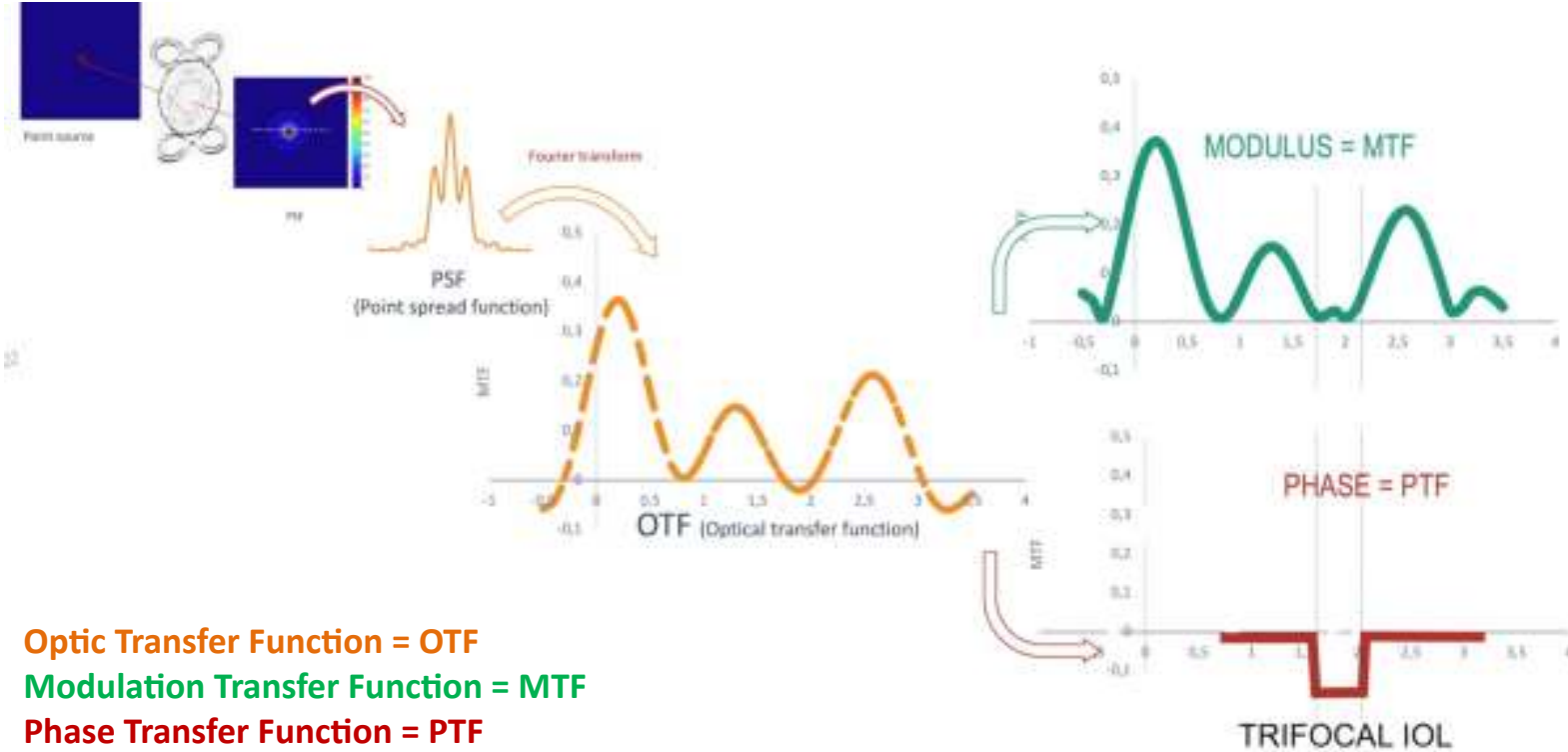


Artis Symbiose MID/PLUS (Cristalens/Afidera)





Optical Principle: Minimizing Phase Reversals



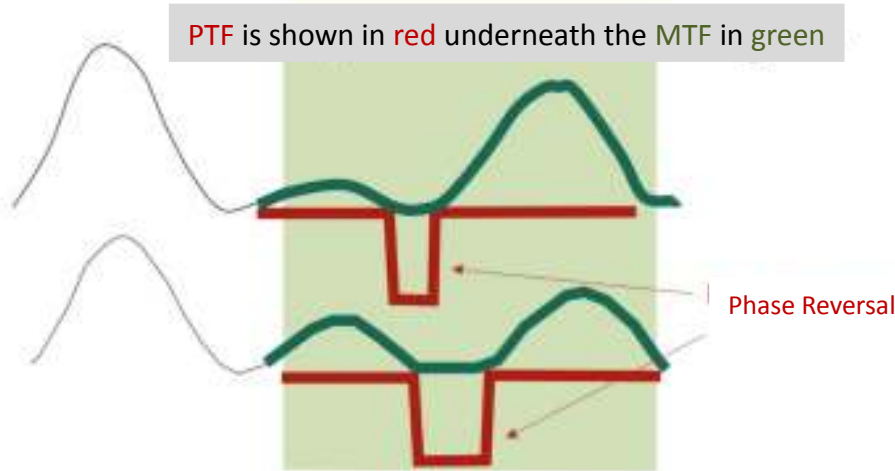
Optic Transfer Function = OTF

Modulation Transfer Function = MTF

Phase Transfer Function = PTF



Phase Reversal = Blurred Pictorial Quality



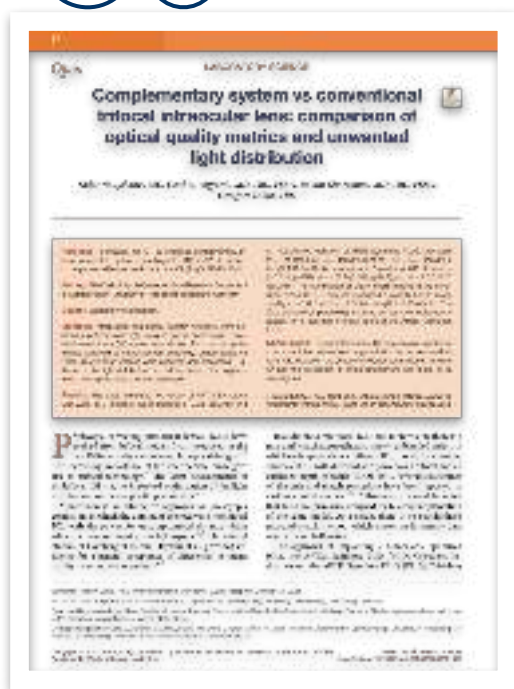
Bifocal MIOL
Phase Reversal
between both main foci

Trifocal MIOL
Phase Reversal
at 60cm intermediate focus

Phase Continuity = sharp image

Phase Reversal = blurred image

Optical Bench Analysis of Artis Symbiose System*



Purpose: To evaluate the ARTIS Symbiose complementary intraocular lens (IOL) system (consisting of the MD and PLS models) in comparison with a conventional trifocal IOL (Novosoft O-Hemupox).

Setting: The Heidelberg Academic Center for Vision Research, Department of Ophthalmology, University of Heidelberg, Heidelberg, Germany.

Design: Laboratory investigation.

Methods: Modulation and phase transfer functions were obtained in a synchrotron light using an optical bench setup. Five- and six-wave spatial Nyq/N values were derived from optical quality metrics weighted by natural contrast sensitivity. Uniform static Airy Fraunhofer diffraction images were acquired and processed. Furthermore, the light distribution beyond the center of a complementary point spread function was assessed.

Results: The peak simulated VA values of ARTIS Symbiose MD were at 0.3 cycles/deg (C/D) of defocus ($-0.22 \log \text{MAR}$) and

at -1.5 D (0.00 $\log \text{MAR}$) of ARTIS Symbiose PLS. They were at 0.0 D or defocus ($-0.01 \log \text{MAR}$) and at -2.0 D (0.01 $\log \text{MAR}$) of Novosoft O-Hemupox. The optical bench simulation of the ARTIS Symbiose MD and PLS models produced a slightly better image quality at -1.0 D and -1.5 D than Novosoft O-Hemupox. The GLS yielded comparable light spread across the studied range except for a localized intensity spike of the ARTIS Symbiose GLS.

Conclusions: The complementary IOL system may yield better monocular intermediate VA compared with the conventional trifocal IOL. However, the effect of a near far summation in terms of VA and the perception of photic phenomena still needs to be investigated.

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Optical Bench Analysis of Artis Symbiose System*

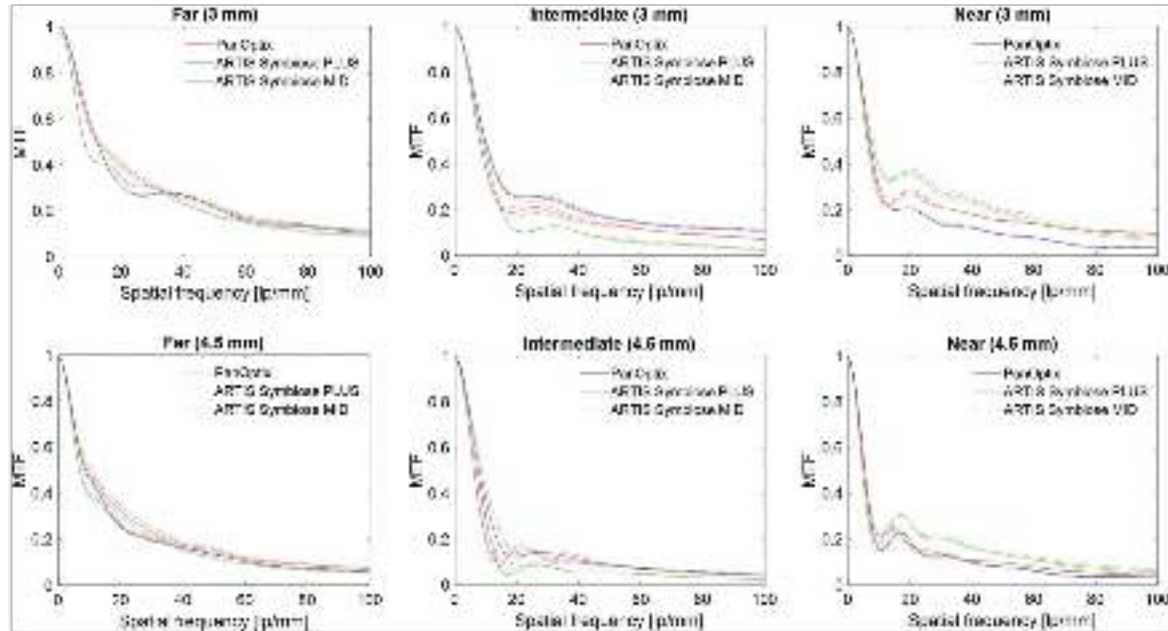


Figure 1. MTF results at far, intermediate, and near focus of the studied IOL at 3 mm and 4.5 mm pupil sizes. Two samples per model were measured; the dotted lines show the values of each lens sample separately; the solid lines refer to the mean of 2 samples of the same IOL model. MTF = modulation transfer function



Optical Bench Analysis of Artis Symbiose System*

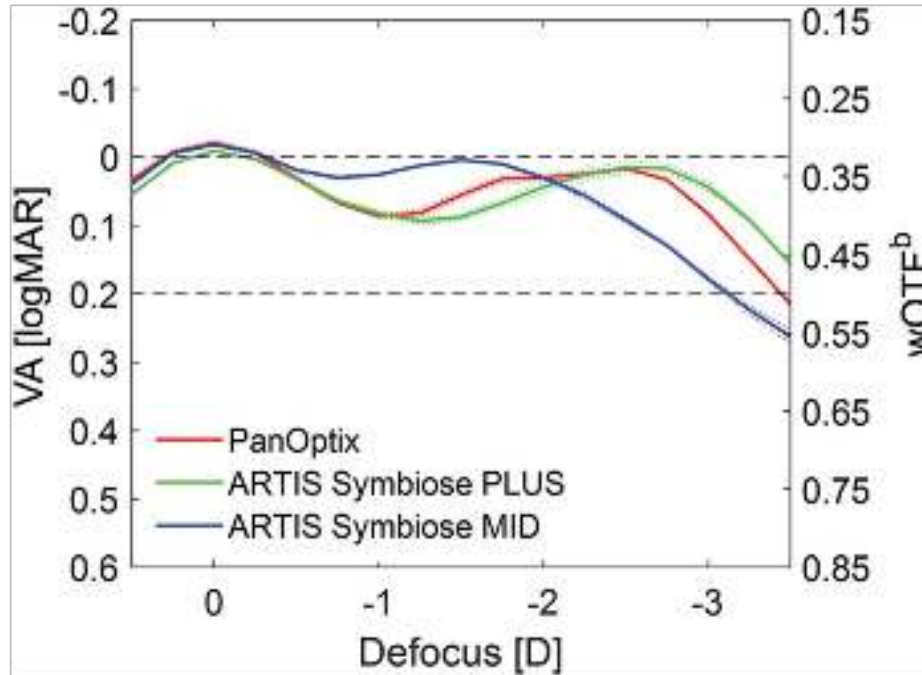
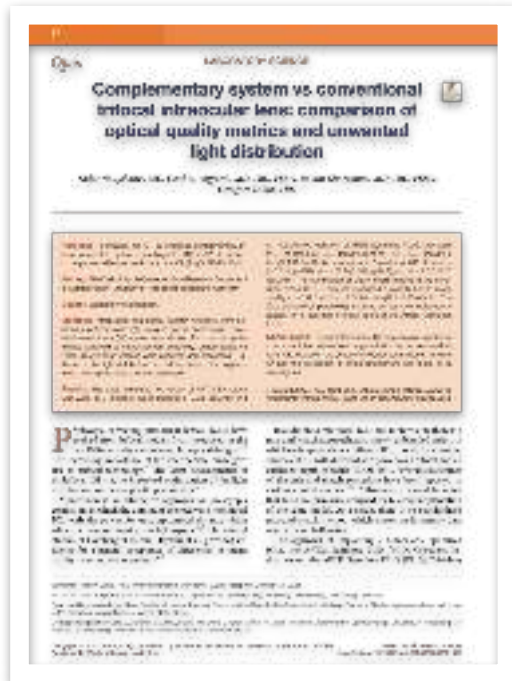


Figure 2. Simulated VA values and the corresponding values of the weighted optical transfer function to the power of $b = -0.36$ ($wOTF^b$) at the defocus between +0.5 D and -3.5 D at the spectacle plane. Two samples per model were measured: the dotted lines show the values of each lens sample separately; the solid lines refer to the mean of 2 samples of the same IOL model. wOTF = weighted optical transfer function



Optical Bench Analysis of Artis Symbiose System*



WHAT WAS KNOWN

- A nonstandardized mix and match procedure, in which different IOL models are implanted, has been shown to provide good bilateral VA outcomes offering a high accommodation level.
- A new blended vision system consists of 2 IOLs that are specifically designed to complement each other and create binocular trifocality.

WHAT THIS PAPER ADDS

- VA derived from weighted optical transfer function demonstrates a good agreement with clinical results found in the literature and its usefulness to predict postoperative defocus curves of trifocal IOLs.
- The VA simulations based on optical quality measurements indicate better monocular intermediate VA in the complementary system than the conventional trifocal IOL.

Patients and Methods

- First clinical results of 48 patients (96 eyes)
- Examination after 1 week, 1 month, 3 months, 6 months, 12 months
- The following parameters were evaluated: UCDVA, BCDVA, UCIVA, DCIVA, UCNVA, DCNVA, Defocuscurve, Halo&Glare Simulator
- Mean Age: 70 ± 8 years

Number of patients (n), (eyes)	48, (96 eyes)
1 month postoperative	n=40
6 months postoperative	n=29
12 months postoperative	n=17
M : F	22:26
average age	70 ± 8 years

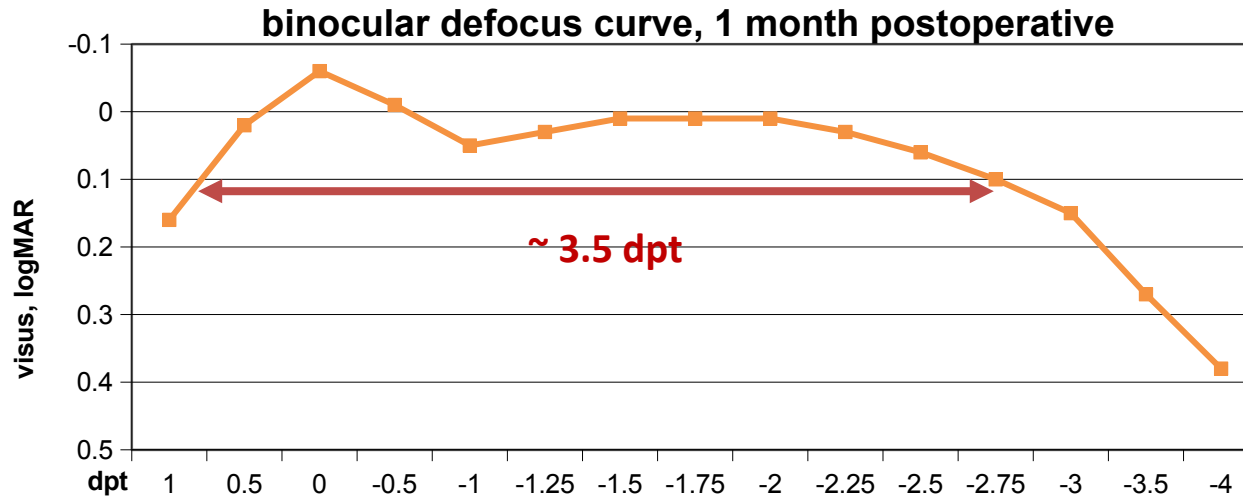


*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Artis Symbiose MID/PLUS: Postoperative results*

1 month postoperative			
UDVA (4m)	BDVA (4m)	UIVA (80cm)	DIVA (80cm)
OU	OU	OU	OU
0.02 ± 0.07	-0.06 ± 0.04	0.00 ± 0.07	0.03 ± 0.07

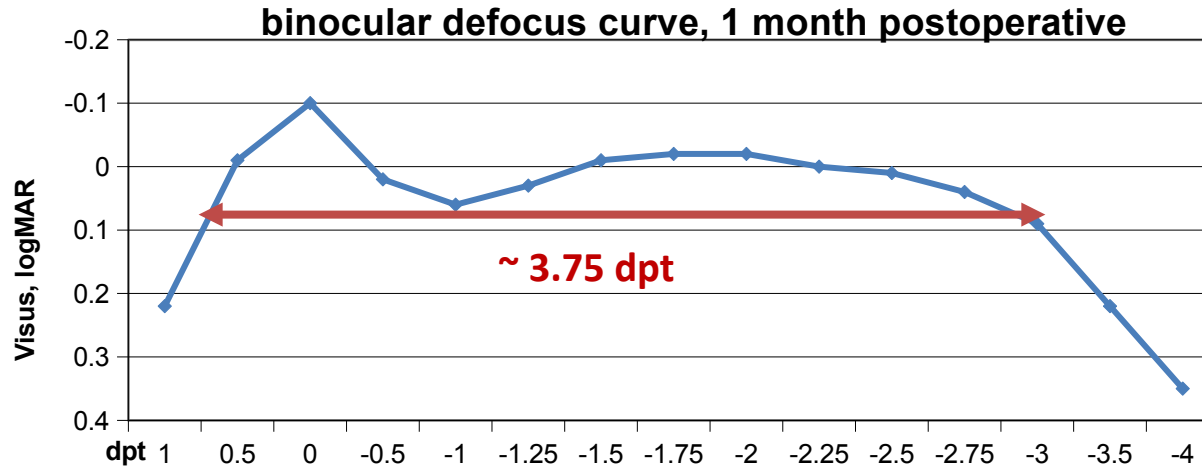


*Data on file: International Vision Correction Research Center (IVCRC), University Eye Clinic, Heidelberg



Alcon AcrySof IQ Panoptix: Postoperative results*

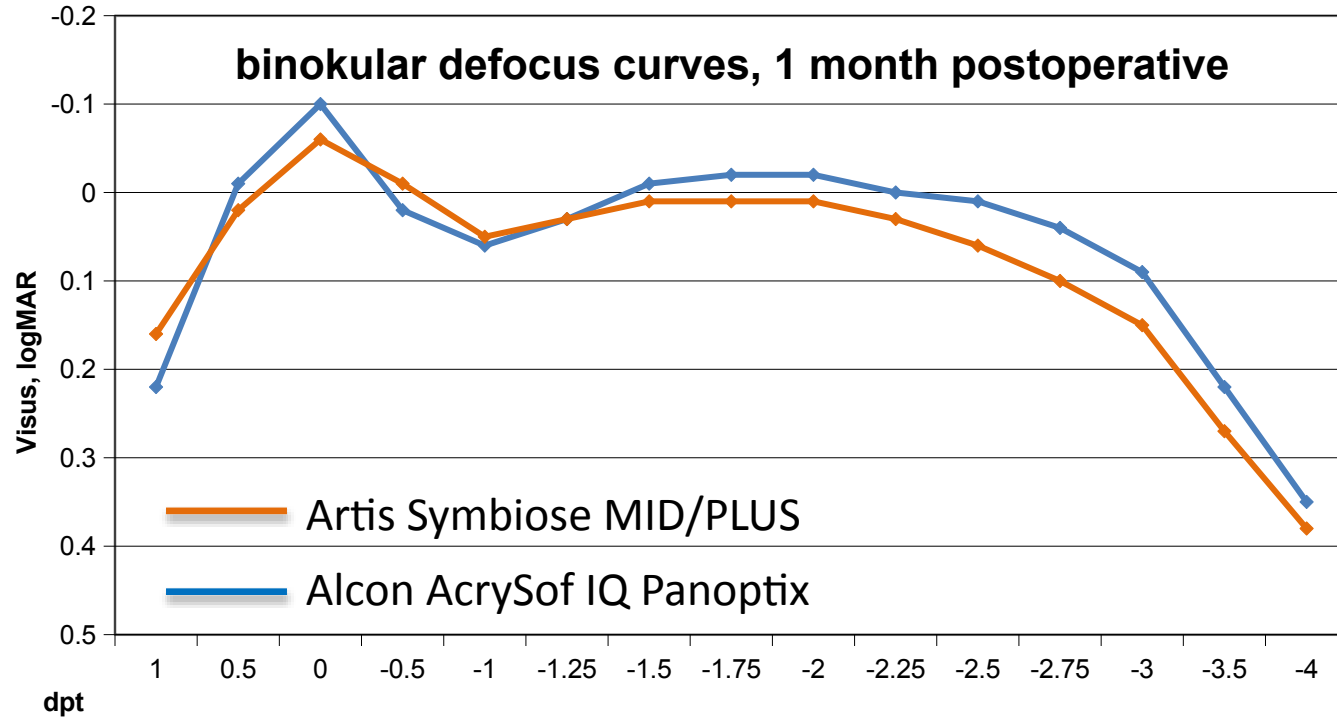
1 month postoperative, n=20			
UDVA (4m)	BDVA (4m)	UIVA (80cm)	DIVA (80cm)
OU	OU	OU	OU
-0.04 ± 0.09	-0.10 ± 0.07	0.01 ± 0.09	0.02 ± 0.09



*Data on file: International Vision Correction Research Center (IVCRC), University Eye Clinic, Heidelberg



Artis Symbiose MID/PLUS vs Alcon AcrySof IQ Panoptix*



*Data on file: International Vision Correction Research Center (IVCRC), University Eye Clinic, Heidelberg



Artis Symbiose MID/PLUS: postoperative results

6 months postoperative							
UDVA (4m)	BDVA (4m)	UIVA (80cm)	DIVA (80cm)	UIVA (60cm)	DIVA (60cm)	UNVA (40cm)	DCNVA (40cm)
OU	OU	OU	OU	OU	OU	OU	OU
-0.01 ± 0.06	-0.08 ± 0.07	-0.01 ± 0.09	0.00 ± 0.06	0.00 ± 0.07	0.01 ± 0.09	0.09 ± 0.08	0.10 ± 0.07
12 months postoperative							
UDVA (4m)	BDVA (4m)	UIVA (80cm)	DIVA (80cm)	UIVA (60cm)	DIVA (60cm)	UNVA (40cm)	DCNVA (40cm)
OU	OU	OU	OU	OU	OU	OU	OU
-0.02 ± 0.08	-0.10 ± 0.03	-0.02 ± 0.06	0.00 ± 0.04	-0.02 ± 0.03	-0.02 ± 0.02	0.09 ± 0.14	0.04 ± 0.08



*Data on file: International Vision Correction Research Center (IVCRC), University Eye Clinic, Heidelberg



Alcon AcrySof IQ Panoptix: Postoperative Ergebnisse

6 months postoperative							
UDVA (4m)	BDVA (4m)	UIVA (80cm)	DIVA (80cm)	UIVA (60cm)	DIVA (60cm)	UNVA (40cm)	DCNVA (40cm)
OU	OU	OU	OU	OU	OU	OU	OU
-0.12 ± 0.22	-0.11 ± 0.06	-0.04 ± 0.05	-0.04 ± 0.07	-0.05 ± 0.07	-0.04 ± 0.08	0.02 ± 0.11	0.00 ± 0.08

12 months postoperative							
UDVA (4m)	BDVA (4m)	UIVA (80cm)	DIVA (80cm)	UIVA (60cm)	DIVA (60cm)	UNVA (40cm)	DCNVA (40cm)
OU	OU	OU	OU	OU	OU	OU	OU
-0.08 ± 0.07	-0.11 ± 0.07	-0.03 ± 0.06	-0.04 ± 0.07	-0.07 ± 0.05	-0.04 ± 0.08	0.01 ± 0.07	-0.02 ± 0.08



*Data on file: International Vision Correction Research Center (IVCRC), University Eye Clinic, Heidelberg



CLINICAL CASES



Artis Symbiose IOL Calculation: Patient 1

81 years old patient, Cataracta corticonuclearis on both eyes

OD sc = 0,52 logMAR, cc (+3,50/-0,75/78°) = 0,24 logMAR

OS sc = 0,34 logMAR, cc (+3,75/-0,75/104°) = 0,24 logMAR

OD: 20.5 dpt sph/ 1.5 dpt cyl. @ 23°

OS: 19.0 dpt sph/ 0.75 dpt cyl. @ 139°

Rechts (OD) 1. AUGE		Positionierung torische IOL/Achse					
IOL		Theoretische Restrefraktion					
SPH	ZYL	SPH	ZYL	ACHSE	SE	nach Formel	Inzision bei 90°
20.5	1.5	-0,23	+0,00	23°	-0,19	SRK-T	
		-0,28			-0,24	Holladay 1	
		-0,35			-0,31	Hoffer Q	
		-0,29			-0,25	Haigis	
		-0,19			-0,35	Barrett	
		-0,28			-0,24	EVO Formula	

→ OD Phako/HKL (Artis Symbiose **PLUS** TORIC, +20.5/cyl:+1.5) on 22.10.2020

Links (OS) 2. AUGE		Positionierung torische IOL/Achse					
IOL		Theoretische Restrefraktion					
SPH	ZYL	SPH	ZYL	ACHSE	SE	nach Formel	Inzision bei 90°
19.0	0.75	+0,06	+0,14	139°	+0,13	SRK-T	
		-0,11			-0,04	Holladay 1	
		-0,28			-0,21	Hoffer Q	
		-0,18			-0,11	Haigis	
		-0,16			-0,09	Barrett	
		-0,06			+0,01	Kane Formula	
		-0,10			-0,03	EVO Formula	

→ OS Phako/HKL (Artis Symbiose **MID** TORIC, +19.0/cyl:+0.75) on 27.10.2020



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg

Visual Acuity Results Artis Symbiose: Patient 1

good functional distance, near and intermediate vision performance
at an early stage already

after 1 month [logMAR]						
	UCDVA	UCNVA	UCIVA	BCDVA	DCNVA	DCIVA
		40cm	66cm		40cm	66cm
Binocular	0,14	0,20	0,10	0,10	0,10	0,20

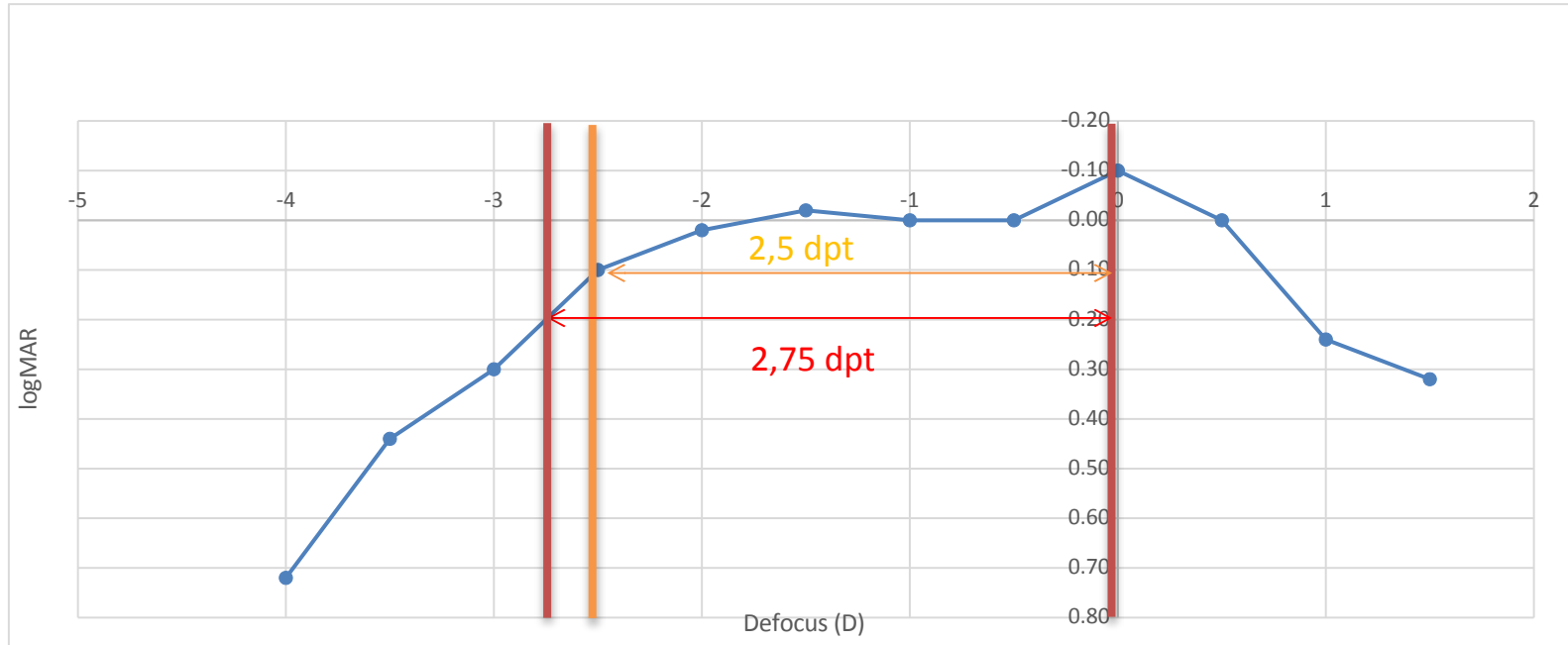
after 3 months [logMAR]						
	UCDVA	UCNVA	UCIVA	BCDVA	DCNVA	DCIVA
		40cm	66cm		40cm	66cm
Binocular	0,10	0,04	0,02	0,08	0,12	-0,02



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Defocus Curve Artis Symbiose Binocular: Patient 1



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg

Artis Symbiose IOL Calculation: Patient 2

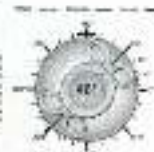
85 years old patient, Cataracta corticonuclearis on both eyes

OD sc = 0,80 logMAR, cc (-0,50/-/-)=0,70 logMAR

OS sc = 0,18, logMAR cc (-0,75/-/-) = 0,10 logMAR

OD: 20.5 dpt sph/ 0.75 dpt cyl. @ 46°

OS: 20.5 dpt sph

Actual IOL		Theoretische Refraktion						Positionierung relative IOL-Kapsel	
SFH	Zn	SFH	Zn	AC-HSE	SE	nach Formel			
20.0	0.75	-0.75	+0.25	47°	-0.02	Sph-T			
		-0.01			-0.04	Hilfsfkt 1			
		-0.01			+0.29	Hilfsfkt 2			
		18.00			-0.75	Hilfsfkt 3			
		-0.75			-0.06	Hilfsfkt 4			
		-0.35			+0.25	Hilfsfkt 5			
		-0.75			+0.59	Hilfsfkt 6			
		-0.46			-0.36	Hilfsfkt 7			
		-0.35			-0.04	Hilfsfkt 8			
		-0.35			-0.27	Hilfsfkt 9			
		-0.35			-0.02	Hilfsfkt 10			
		-0.35			-0.35	Hilfsfkt 11			
		-0.35			-0.27	Hilfsfkt 12			
		-0.35			-0.41	Hilfsfkt 13			

IOL		Theoretische Refraktion						ARTIS Symbiose MID 2-Pages	
SFH	Zn	SFH	Zn	AC-HSE	SE	nach Formel			
20.0	0	-0.21			-0.21	Sph-T			
		-0.07			-0.07	Hilfsfkt 1			
		-0.06			-0.06	Hilfsfkt 2			
		40.00			40.00	Hilfsfkt 3			
		-0.17			-0.17	Hilfsfkt 4			
		-0.04			-0.04	Kern Formeln			
		-0.08			-0.08	End Formeln			
20.5	0	-0.55			-0.55	Sph-T			
		-0.39			-0.39	Hilfsfkt 1			
		-0.33			-0.33	Hilfsfkt 2			
		-0.27			-0.27	Hilfsfkt 3			
		-0.52			-0.52	Hilfsfkt 4			
		-0.37			-0.37	Kern Formeln			
		-0.39			-0.39	End Formeln			

→ OD Phako/HKL (Artis Symbiose **Plus** toric, +20,5/0,75 dpt.) on 10.11.2020

→ OS Phako/HKL (Artis Symbiose, +20,5 **MID** dpt.) on 12.11.2020



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Visual Acuity Results Artis Symbiose: Patient 2

good functional distance, near and intermediate vision performance
at an early stage already

after 1 month [logMAR]						
	UCDVA	UCNVA	UCIVA	BCDVA	DCNVA	DCIVA
		40cm	66cm		40cm	66cm
Binocular	-0,10	0,10	0,00	-0,10	0,10	0,00

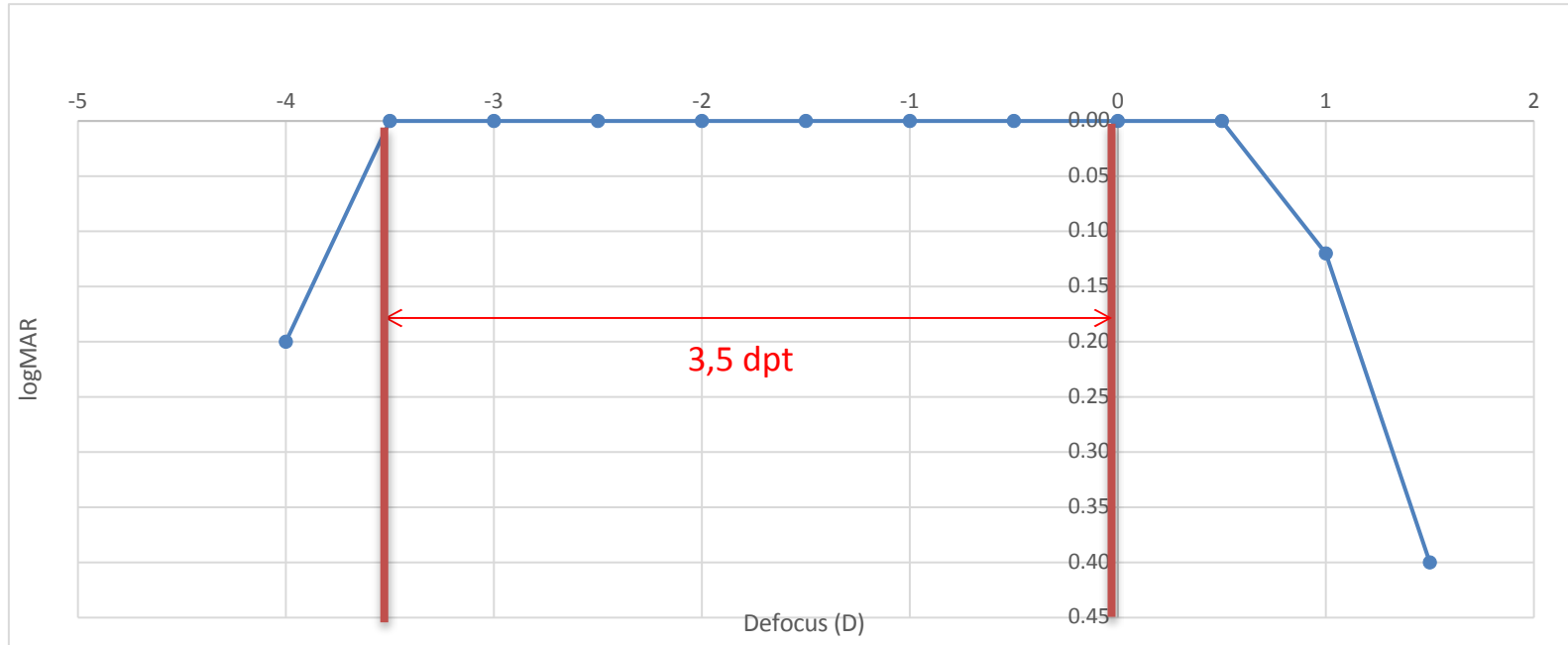
after 3 months [logMAR]						
	UCDVA	UCNVA	UCIVA	BCDVA	DCNVA	DCIVA
		40cm	66cm		40cm	66cm
Binocular	0,00	0,00	0,00	Gbn	Gbn	Gbn



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Defocus Curve Artis Symbiose Binocular: Patient 2



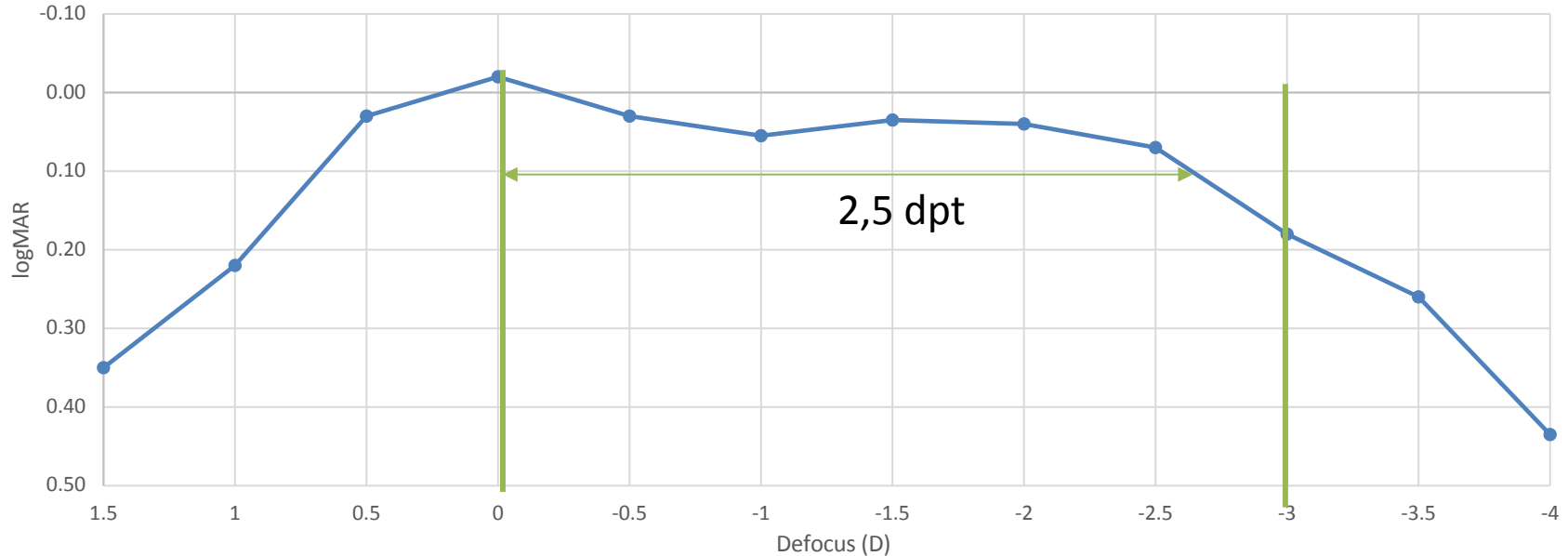
*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Defocus Curve Artis Symbiose Binocular: Patient 3

above 2,5 dpt defocus, visual acuity 0,10 logMAR or better

Artis Symbiose defocus curve 3 M



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Halo + Glare

Less glare sensitivity and photoptic phenomena



*Data on file: International Vision Correction Research Center (IVCRC), Universitäts-Augenklinik Heidelberg



Summary Artis Symbiose

- Complementary, diffractive trifocal lens system
- good functional distance, near and intermediate vision performance at an early stage already
- Continuous binocular VA between 0.0- 0.1 logMAR or better für distance, near and intermediate vision performance
- Excellent straight defocus curve up to 3.5 dpt.
- Less glare sensitivity and photoptic phenomena
- Competitive outcomes to established trifocal IOIs



**Steinbeis-Forschungszentrum
The David J Apple Center
for Vision Research**



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International Vision Correction
Research Center Network