

 Fast  Automated  Quantitative











neos[®]

the world's first neurophthalmoscope

8

exams
in 12 minutes

-  Ocular Alignment
-  Fusional Amplitudes
-  Gaze holding
-  Saccades
-  Smooth Pursuit
-  Visual Field Screening
-  Afferent Pupillary Function
-  Efferent Pupillary Function

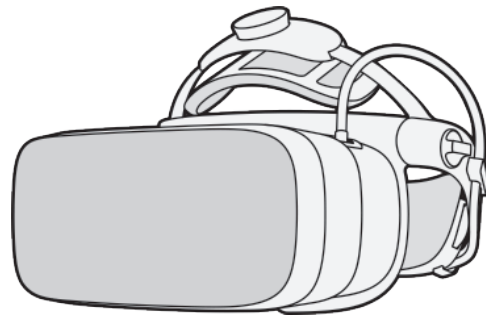
neos[®]

- ✓ Increase patient comfort with a head-mounted device
- ✓ Improve clinical efficiency with fast, automated, quantitative exams
- ✓ Inspire greater precision with quantitative reporting

Industry-leading eye tracking

neos[®] uses infrared eye tracking that records eye movements at **200Hz**, comfortably mounted in a headset that features **active cooling** to ensure patient comfort.

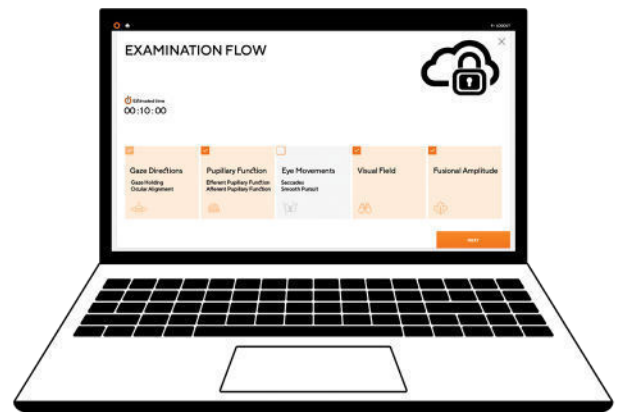
neos[®] is compatible with contact lenses and includes a range of **refractive error correction** lens inserts.



Data securely in the cloud

neos[®] processes all data in the cloud, enabling you to easily **access reports from your desk** and attach them to your local electronic health record system.

neos[®] cloud data storage is fully **GDPR compliant** and maintained on servers hosted in Switzerland, providing you with **confidence in data security**.





“My goal is to democratize specialist knowledge of neuro-ophthalmologists, enabling the earlier diagnosis of neurological disorders.”

Dr. Mathias Abegg, MD, PhD
Co-Founder and Medical Director
machineMD



machineMD was founded by an interdisciplinary team with a shared vision for a world where patients receive an accurate, fast, and early diagnosis of brain disorders. Together with our global network of partners and medical experts, our mission is to radically improve the measurement of brain function.



Gaze Holding

- ✓ Binocular fixation
- ✓ 9 gaze positions $\pm 10^\circ$
- ✓ Measures gaze position

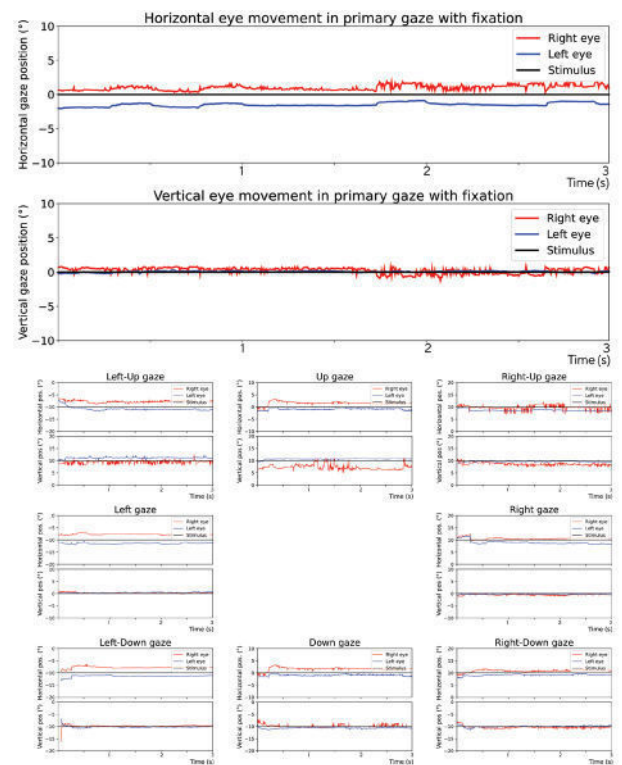
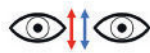


Optimized stimuli

Fixation and image clarity of a visual target require placement and maintenance of the fovea on the target¹.

neos[®] presents a novel stimulus: an Unidentified Flying Object, UFO, projected at infinite distance (over 20m).

In addition to the neos[®] report for gaze holding, stability of fixation is also interesting to review in the neos[®] tests for smooth pursuit and during the fusional amplitude tests of convergence.



1. Rucker JC. Nystagmus and Saccadic Intrusions. Contin Minneap Minn. 2019;25(5):1376-1400. doi:10.1212/CON.0000000000000772



In Switzerland, Ophthalmologists and Neurologists often use the following TARMED codes for the examination of Gaze Holding under binocular fixation using an infrared camera:

- 08.1050 Augenbewegungsableitung mittels Infrarotkamera, beide Augen
- 08.0410 Vollständiger orthoptischer Status, beidseitig
- 08.0490 Neuroophthalmologischer Status
- 09.0630 Elektronystagmografie

Ocular Alignment

- ✓ Automated alternate cover test
- ✓ 9 gaze positions $\pm 10^\circ$
- ✓ Measures median deviation



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Automated alternate cover test

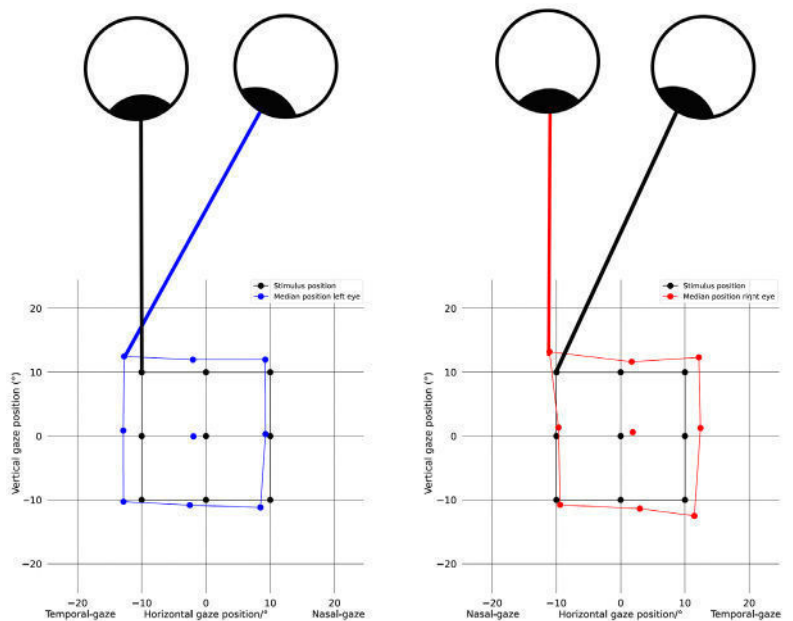
The neos® test sequence comprises alternate covers lasting 1.5 seconds each, beginning with primary gaze followed by the $\pm 10^\circ$ cardinal gaze positions.

Presented in the style of the Hess Screen

In the neos® report, black points represent the stimulus position for the fixating eye, and the red / blue points represent the median position of the covered eye.

Median latent deviation

The difference between the black dot and the coloured dot is the median deviation of the phoria in that gaze direction.



Possible deviations include¹:

- exodeviations, in which the eyes are turned laterally relative to one another
- esodeviations, in which the eyes are turned medially relative to one another
- hyperdeviations, in which one eye is higher than the other.

1. Rucker JC, et al. The neuro-ophthalmological examination. Handb Clin Neurol. 2011;102:71-94. doi:10.1016/B978-0-444-52903-9.00009-1

TAR
MED

In Switzerland, Ophthalmologists often use the following TARMED code for the examination of Ocular Alignment:

- 08.0430 Koordinometrie, beidseitig
- 08.0410 Vollständiger orthoptischer Status, beidseitig

Efferent Pupillary Function

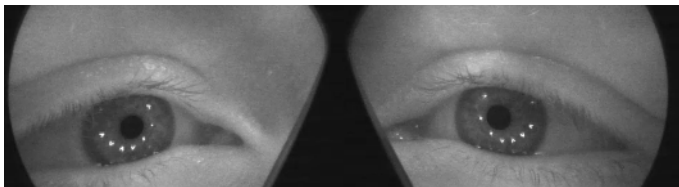
- ✓ Tests dilation rate of both eyes
- ✓ No pharmacological testing
- ✓ Measures pupil diameter



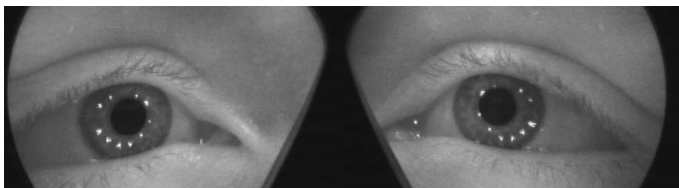
Manual examinations miss 50% of anisocoria¹

Pupil diameter and dynamics are determined by the interaction between the sympathetic and parasympathetic nervous systems. Whereas the parasympathetic system primarily drives pupillary constriction, the sympathetic system primarily drives pupillary dilation².

Eyes observed via neos[®] infrared cameras with bright screens:

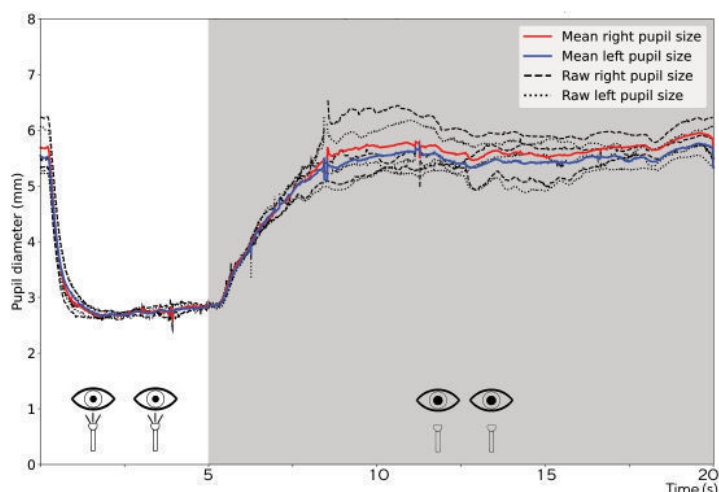


Eyes observed via neos[®] infrared cameras with dark screens:



neos[®] presents a bright stimulus for 5 seconds, comprising an icy landscape with an igloo fixation point, projected at infinite distance (over 20m). neos[®] then presents a dark screen with no fixation point for 15 seconds.

neos[®] repeats this sequence 4 times, and the mean pupil diameter is highlighted for each eye in the below report.



1. Couret D, et al. Reliability of standard pupillometry practice in neurocritical care: an observational, double-blinded study. Crit Care Lond Engl. 2016. Mar 13;20:99. doi:10.1186/s13054-016-1239-z

2. Bower, M. M., et al. (2019). Quantitative Pupillometry in the Intensive Care Unit. Journal of Intensive Care Medicine. doi:10.1177/0885066619881124

**TAR
MED**

In Switzerland, Ophthalmologists often use the following TARMED codes for the examination of pupillometry:

08.1310 Pupillometrie, beidseitig
08.0490 Neuroophthalmologischer Status

Afferent Pupillary Function

- ✓ Automated swinging flashlight test
- ✓ Eliminates ambient light
- ✓ Measures pupil diameter



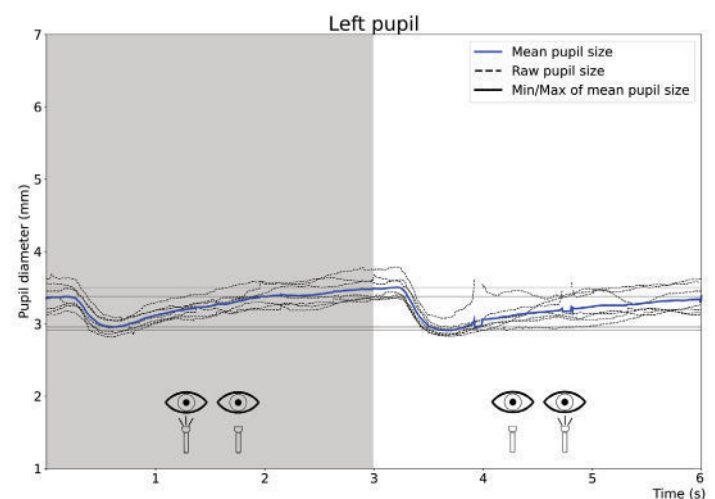
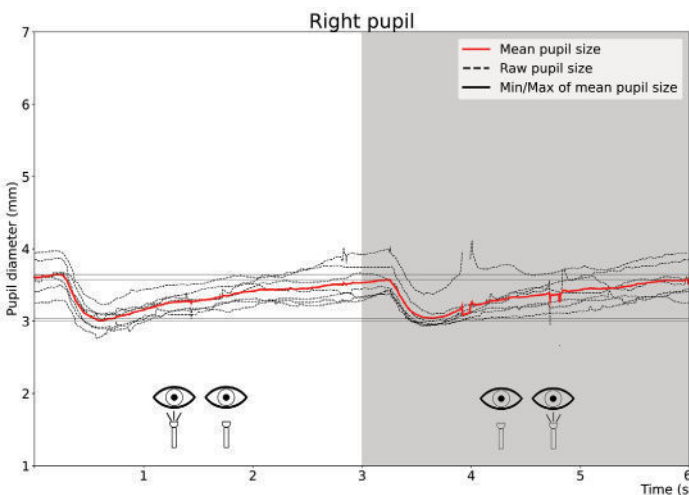
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Only 40% of RAPD magnitudes are correctly estimated via manual swinging flashlight tests¹.

Quantitative pupillometry can provide more reliable measurements with a lower error rate². Pupillometry devices provide variables including maximum size, minimum size, constriction velocity, constriction amplitude, and response latency.

neos® uses an automated, digitalized version of the swinging flashlight test: displaying a bright stimulus to one eye while the other eye is shown a dark screen for 3 seconds. The stimulus is repeatedly alternated between the two eyes.

neos® plots minimum and maximum mean pupil diameters for each eye as black horizontal lines obtained during the test sequence.



1. Boucher T, Fortin É, Evoy F. The standard swinging flashlight test: reliable or not (P1.9-009). Neurology. 2019; 92(15 Supplement): P1.9-009.
2. Bower MM, et al. Quantitative Pupillometry in the Intensive Care Unit. J Intensive Care Med. 2021;36(4):383-391. doi:10.1177/0885066619881124



In Switzerland, Ophthalmologists often use the following TARMED codes for the examination of pupillometry:

- 08.1310 Pupillometrie, beidseitig
- 08.0490 Neuroophthalmologischer Status

Horizontal Smooth Pursuit

✓ Velocities: 0.0625Hz and 0.125Hz.

✓ Amplitude: 15°

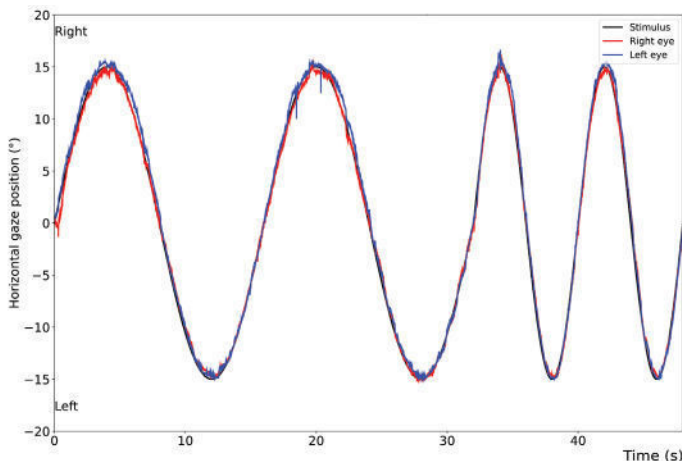
✓ Measures gaze position



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neos® presents a forest scene with a fixation point of a fairy in a glowing circle, projected at infinite distance (over 20m). The stimulus is always shown under binocular conditions.

neos® measures gaze position while the patient tracks the fairy moving in the horizontal direction with two different velocities: 0.0625Hz followed by 0.125Hz. Two repetitions are made for each velocity with an amplitude of 15°.



Smooth-pursuit movements allow clear vision of a moving target by holding the image steady on the fovea¹. Pursuit performance requires focused attention to track a particular object.

Saccades are the fastest eye movements, with speeds as high as 700°/s and durations usually less than a tenth of a second. Their main function is to bring new images on to the fovea.

neos® tests saccades by presenting the stimulus at ±10° and ±20° both horizontally and vertically. Each position is repeated several times and always binocularly.

neos® measures gaze position relative to the stimulus, and also reports peak velocity for each eye at each angle (see right page).

Saccade related parameters include amplitude, saccadic latency, saccadic velocity, and saccadic accuracy².

1. Kheradmand A, et al. Eye movements in vestibular disorders. Handb Clin Neurol. 2016;137:103-117. doi:10.1016/B978-0-444-63437-5.00008-X

2. Larrazabal AJ, et al. Video-oculography eye tracking clinical applications. Comput Biol Med. 2019;108:57-66. doi:10.1016/j.combiomed.2019.03.025



In Switzerland, Ophthalmologists and Neurologists often use the following TARMED codes for the examination of smooth pursuit using infrared cameras:

08.1050 Augenbewegungsableitung mittels Infrarotkamera, beide Augen

08.0490 Neuroophthalmologischer Status

09.0640 + Erweiterte Nystagmografie bei Elektronystagmografie

Horizontal & Vertical Saccades

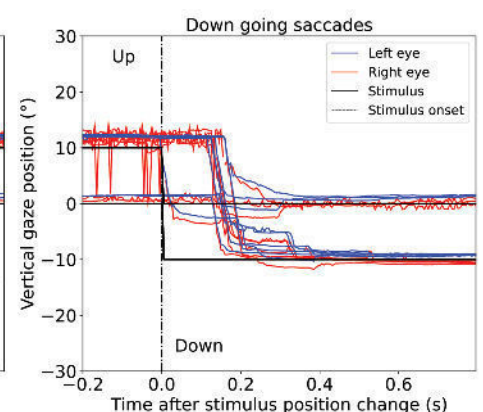
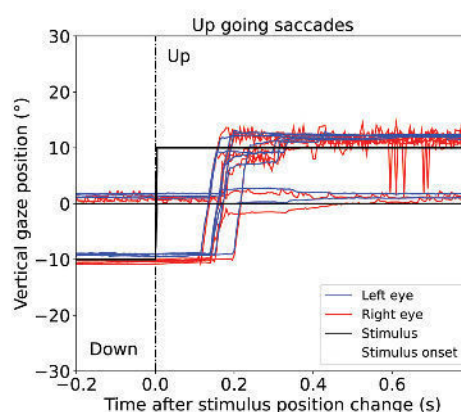
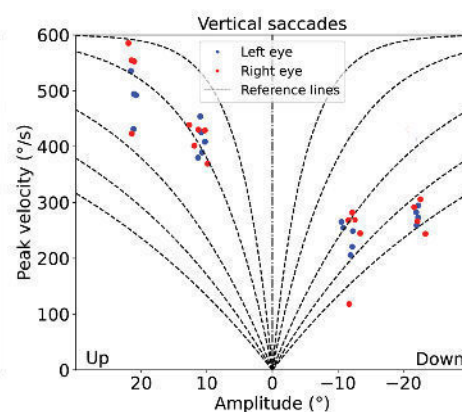
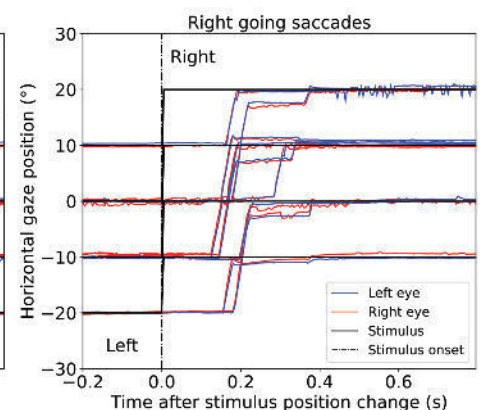
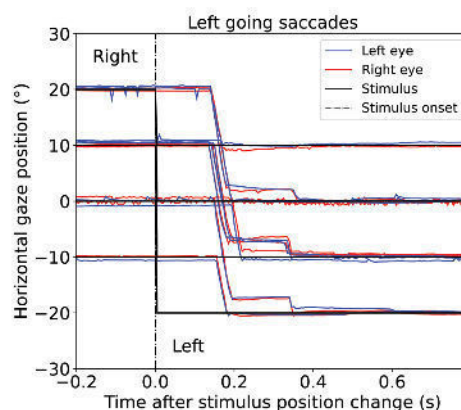
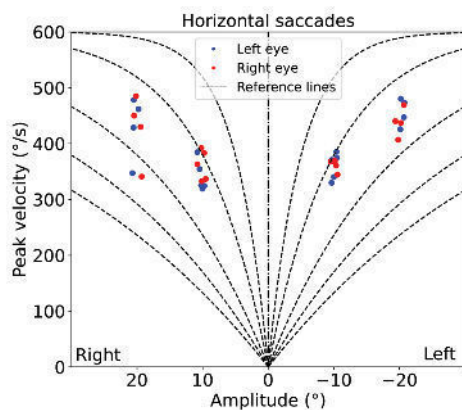
✓ Prosaccadic eye movements

✓ Tests $\pm 10^\circ$ and $\pm 20^\circ$

✓ Measures gaze position and peak velocity



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Peak velocity reference lines generated according to formulae in the book by Leigh RJ, Zee DS. The Neurology of Eye Movements.



In Switzerland, Ophthalmologists and Neurologists often use the following TARMED codes for the examination of saccades using infrared cameras:

- 08.1050 Augenbewegungsableitung mittels Infrarotkamera, beide Augen
- 08.0490 Neuroophthalmologischer Status
- 09.0640 + Erweiterte Nystagmografie bei Elektronystagmografie

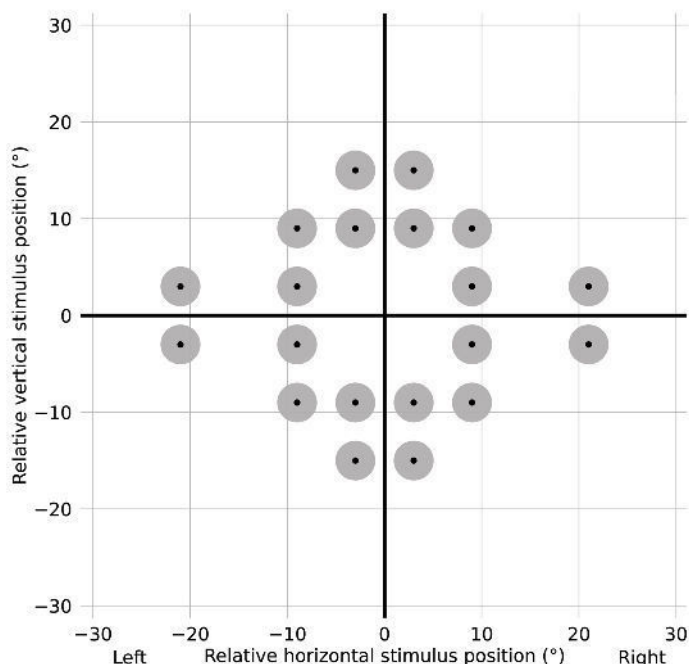
Visual Field Screening

- ✓ Adaptive, gaze dependent strategy
- ✓ Static suprathreshold perimetry
- ✓ Measures central 30°

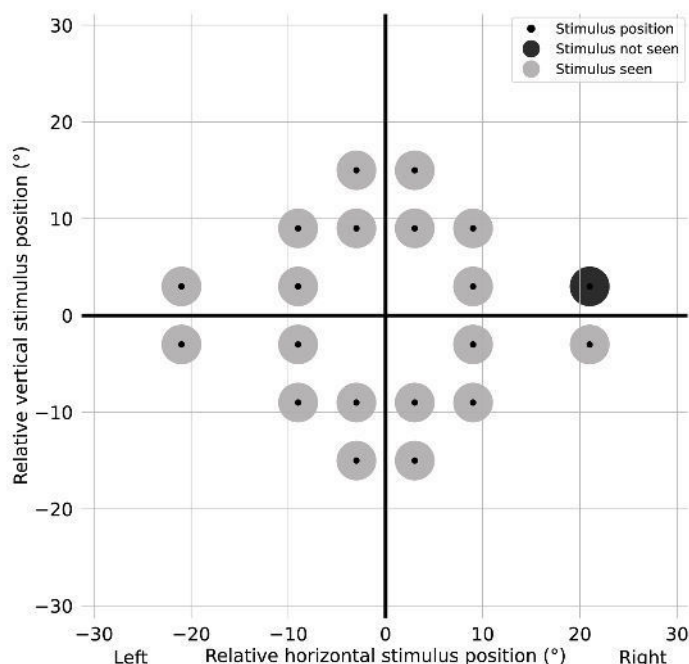
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neos® performs this test for both eyes using monocular stimuli. The patient is shown a fixation cross and a stimulus with maximal brightness appears according to an adaptive pattern. neos® detects the saccadic movement to the location of the stimulus and moves the fixation target accordingly.

Visual Field Left Eye



Visual Field Right Eye



In Switzerland, Ophthalmologists often use the following TARMED codes for a coarse visual field examination of both eyes:

- 08.0350 Automatisierte statische Perimetrie, Kurzprogramm, erstes Programm, erstes Auge
- 08.0360 Automatisierte statische Perimetrie, Kurzprogramm, jedes weitere Programm
- 08.0490 Neuroophthalmologischer Status

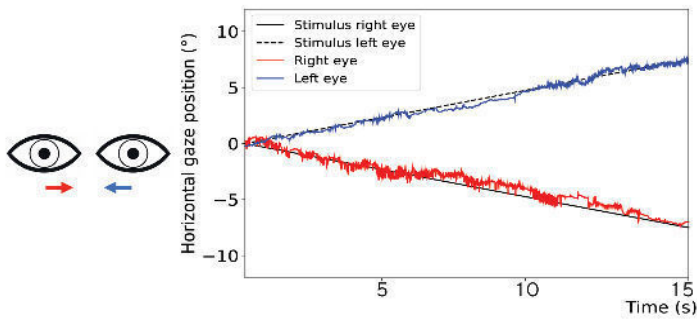
Fusional Amplitudes

- ✓ Tests fusional reserves
- ✓ Rest time between tests
- ✓ Measures gaze position

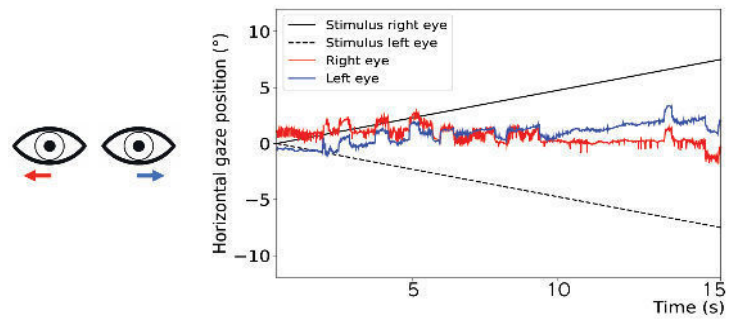


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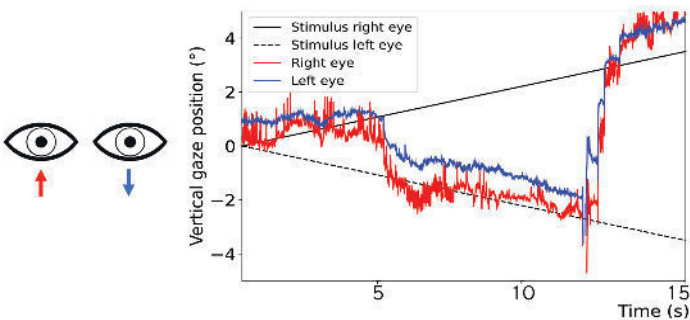
Horizontal convergence: 7° (12 p.d.)



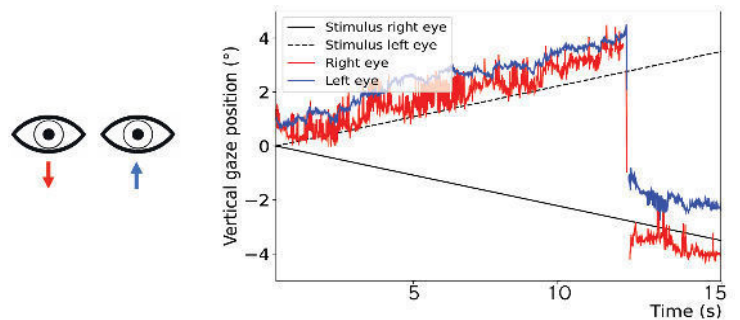
Horizontal divergence: 7° (12 p.d.)



Vertical divergence, left ↓, right ↑: 3° (5 p.d.)



Vertical divergence, left ↑, right ↓: 3° (5 p.d.)



In Switzerland, Ophthalmologists and Neurologists often use the following TARMED codes for the examination of fusional amplitudes using infrared cameras:

- 08.1050 Augenbewegungsableitung mittels Infrarotkamera, beide Augen
- 08.0410 Vollständiger orthoptischer Status, beidseitig
- 09.0640 + Erweiterte Nystagmografie bei Elektronystagmografie



TARMED code	TARMED name & description	Most relevant neos® tests	TARMED time	AL	TL	CHF*
08.1050	Augenbewegungsableitung mittels Infrarotkamera, beide Augen	Gaze holding during binocular fixation Horizontal & vertical saccades Horizontal smooth pursuit Fusional amplitudes	Room: 40 mins Doctor: 15 mins	31.24	162.75	169.86
08.0430	Koordinometrie, beidseitig	Ocular alignment	Room: 15 mins Doctor: 2 mins	4.17	72.33	66.19
08.1310	Pupillometrie, beidseitig	Efferent Pupillary function Afferent Pupillary function	Room: 10 mins Doctor: 10 mins	22.4	38.95	54.93
08.0350	Automatisierte statische Perimetrie, Kurzprogramm, erstes Auge	Visual Field	Room: 14 mins Doctor: 3 mins	6.73	34.28	35.92
08.0360	Automatisierte statische Perimetrie, Kurzprogramm, jedes weitere Programm	Visual Field	Room: 14 mins Doctor: 2 mins	4.48	28.23	28.57
08.0410	Vollständiger orthoptischer Status, beidseitig - Einzelzeichenvision, Reihenvision bzw. Testvision - Fixation, Führungsauge, Heterophorie, Heterotropie, objektivem und subjektivem Schielwinkel - binokularem Einfachsehen und Stereopsis, Mobilität, Konvergenz, Fusionsbreite.	Gaze holding during binocular fixation Ocular alignment Fusional amplitudes	Room: 40 mins Doctor: 11 mins	22.9	162.75	161.88
08.0490	Neuroophthalmologischer Status - Hirnnerven II - VII kursorisch (Blickfeld, Gesichtsfeld, Bulbusmotilität und Lidmotilität, Hornhautsensibilität, Pupillenmotorik) - Blickmotorik (Kommandobewegungen und Blickbewegungen) - Fixationsruhe (Spontanystagmus und Blickrichtungsnystagmus, Nystagmus bei Fixationsunterbrechung - Sakkadischen Augenbewegungen (Blickzielbewegung, optokinetischer Nystagmus).	Visual Field Horizontal & vertical saccades Horizontal smooth pursuit Gaze holding during binocular fixation	Room: 20 mins Doctor: 20 mins	41.64	47.35	80.57
09.0630	Elektronystagmografie Beinhaltet Prüfung von Spontanystagmus und Blickrichtungsnystagmus sowie Kalorisation, inkl. zwei Spülungen pro Gehörgang; gilt auch für Videonystagmografie.	Gaze holding during binocular fixation	Room: 45 mins Doctor: 30 mins	67.21	187.92	225.93
09.0640	+ Erweiterte Nystagmografie bei Elektronystagmografie Beinhaltet Prüfung von Blickfolgebewegungen, Sakkaden, optokinetischem Nystagmus und weiteren vestibulär ausgelösten Augenbewegungen.	Horizontal & vertical saccades Horizontal smooth pursuit Fusional amplitudes	Room: 15 mins Doctor: 12 mins	26.88	51.25	69.80

*CHF rates calculated based on national averages and are not a guarantee of reimbursement