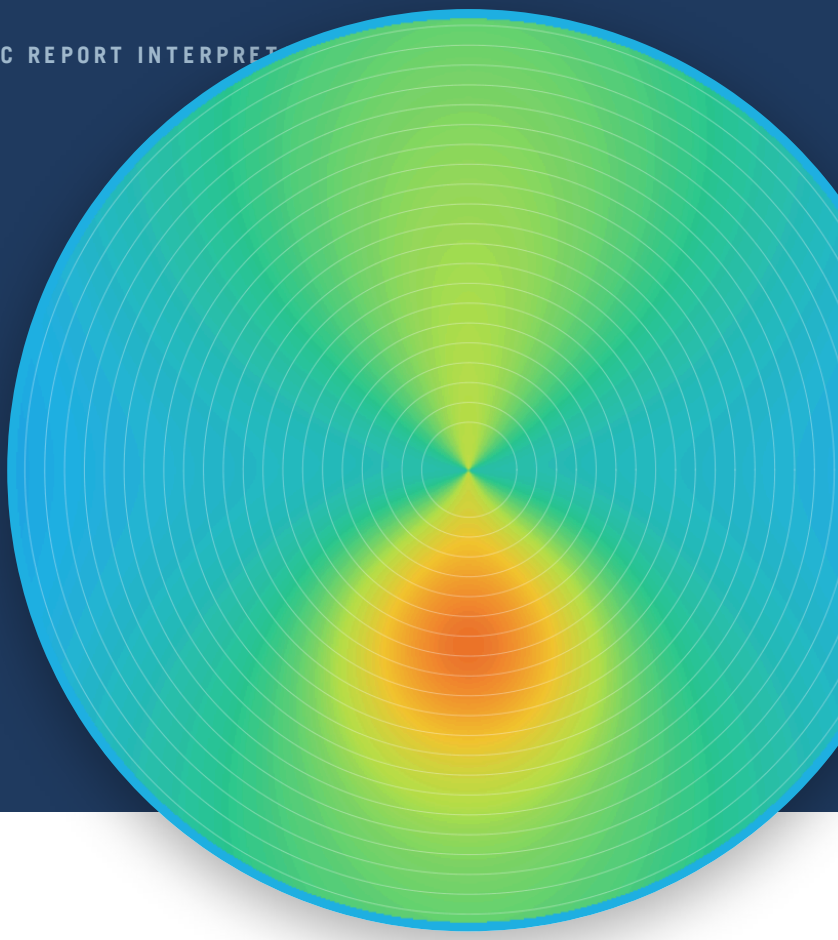

Reading the CA-800 Report

An independent, parameter-level interpretation guide to the Topcon CA-800 Corneal Analyzer

EDITION 3.1 · ILLUSTRATED · SEPTEMBER 2026

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A parameter-level clinical companion to the **Topcon CA-800 Corneal Analyzer**: what each report family measures, how to read its numerical fields, which reference values can reasonably be applied, how the same parameter names behave on other instruments, and what the device cannot establish.

Item	Detail
Intended reader	Practising optometrists and ophthalmologists; residents, fellows and ophthalmic technicians as secondary readers
Clinical question	What does this CA-800 output measure, and how should the result be interpreted in context?
Devices and software checked	CA-800 as documented in the manufacturer user manual Rev. 18 (07/12/2023), software 1.6.x; product specification page accessed 17–19 September 2026. Other instruments cited from their manufacturers' public documentation and peer-reviewed literature as listed in the references
Edition	2.1, prepared 20 September 2026, incorporating the first clinical review. Supersedes Edition 2.0 (19 September 2026) and Edition 1.0 (17 September 2026)
Author	[Name, credentials — to be completed before publication]
Clinical reviewer	[Name, credentials, scope of review — to be completed before publication]
Review status	Draft for clinical review. Not yet reviewed. Do not cite as a reviewed resource
Next scheduled review	Twelve months from publication, or earlier on a CA-800 software release, manufacturer notice, or reader-reported error
Funding and interests	Prepared for the Netra Clinical Knowledge Hub, funded by Netra Eye Institute, a clinical practice. Netra does not manufacture, sell or distribute diagnostic instruments and received no manufacturer support for this guide. Netra offers clinical services for several of the conditions discussed; this guide does not describe or recommend those services

What changed in Edition 3.1. Corrections from the first clinical review: the Pentacam 12–16 µm limits re-attributed to the Belin/Ambrósio elevation-difference charts; the KISA% calculation rules stated; the CA-800 NIBUT repeatability study identified as a pre-lens measurement through soft lenses and the 3.18 s study as a symptomatic sample; the TMH comparison limited to the one study and platform; the same-visit repeat spread reframed as a quality check rather than a progression threshold; worked example 5 and the SAI comparison softened to what the evidence supports; TMS-5 and Galilei placed in the hybrid class; the Wang 2003 RMS term combinations named; three figures corrected (5 % marker at 7 s, elevation sign convention, blink-bar labels). **What changed in Edition 3.0.** This illustrated edition carries the complete Edition 2.0 text, tables and appendices, adds fourteen annotated schematic report panels and seventeen explanatory figures, and adopts the retitled, independent presentation described in the front matter. No reference value has changed since Edition 2.0. **What changed in Edition 2.0.** A thirty-second answer and a three-minute reading pathway now open the guide. A cross-device section explains why keratoconus indices, elevation values and tear-breakup endpoints from Pentacam, Keratograph, ATLAS, TMS and hybrid Placido–OCT instruments must not be transferred to the CA-800. Tear-film, meniscus and meibography sections add the published CA-800 reliability data and the TFOS DEWS III (2025) diagnostic criteria. Two worked examples, a pitfalls checklist, a parameter index and a claim-source register have been added. No reference value from Edition 1.0 has been changed; where a figure remains unverified in the manufacturer documentation, that is still stated.

01 The thirty-second answer

A CA-800 report describes the **anterior corneal surface** reconstructed from a Placido reflection, the **tear film** observed over that surface, the **pupil** under programmed lighting, the **visible lid margin glands** under infrared light, and the **fluorescein pattern** under blue light. It does not measure the posterior cornea, corneal thickness, intraocular pressure, corneal biomechanics or the retina.

Read a report in this order and it is difficult to go badly wrong:

1. **Is the acquisition valid?** Calibration, ring coverage, fixation, tear-surface quality, lens history. A single impressive colour map cannot rescue a poor capture.
2. **What does this field actually describe?** Check the unit, the sampling zone and whether the value is device-defined or borrowed clinical context. A colour is meaningful only after its numerical legend has been read.
3. **Is any comparison like-for-like?** Same eye, same scale, same zone, same aperture, same reference surface, same tear-breakup endpoint.
4. **What would confirm or challenge the finding?** A red keratoconus class is a reason to obtain tomography and pachymetry; a short 5% breakup time is a reason to examine the lids and ask about symptoms. Neither is a diagnosis.

Three rules that hold throughout the guide. A **green index is a screening result and a red index is a reason to investigate**; neither replaces a diagnosis. **No universal numerical normal boundary** has been verified for the CA-800 keratoconus, irregularity, asymmetry, aberration or 5% tear-breakup outputs; where this guide gives an orientation value it is population context, not an instrument threshold. And **a cutoff published for another instrument is not a CA-800 cutoff** — K >47 D, I-S >1.4 D, KISA% >100, Pentacam BAD-D ≥1.6 and the Belin/Ambrósio elevation-difference limits each belong to the device and dataset that produced them.

02 The three-minute reading pathway

The sequence below is the interpretation order the rest of this guide expands. Each step names the report to look at, the question to answer, and the section where the detail sits.

Step	Look at	Ask	Section
1	Patient header, eye, date, software version	Is this the right eye, the right visit, the intended baseline?	Acquisition and quality control
2	Raw Placido image; ring tracing; coverage	Are the rings sharp, continuous, correctly traced, with the region of interest covered?	Acquisition and quality control
3	Test order and lens history	Were non-invasive tear and shape measurements obtained before dye, drops or gland expression? How long since lens removal?	Acquisition and quality control
4	Axial map at absolute scale; then tangential	What is the overall pattern? Is any focal steepening reproducible on repeat capture?	Reading the corneal map
5	K tab: Kflat, Ksteep, cylinder, axis, zone diameters	Do the numbers agree with the map, the refraction and the slit lamp?	Keratometry and astigmatism
6	I tab and KC/AK tab: irregularity, asymmetry, KPI class	Is the anterior pattern regular? What does the software class say, and what does it not establish?	Keratorefractive indices; Keratoconus screening indices
7	HEIGHT report (if used)	Which reference surface and fit diameter? Is residual elevation being confused with posterior elevation or thickness?	Height and elevation reports
8	ZER report	At what aperture? Which terms are included in the RMS total?	Zernike coefficients; Optical quality displays
9	PUP report	Under which lighting protocol, and with what adaptation and medication context?	Pupillometry
10	TBT summary and raw movie	Which endpoint — first break or 5% level? Was the recording censored ("> duration")?	Tear breakup
11	Blink, OPI, TMH, MEIB, FLUO	Are the lid, meniscus and gland findings consistent with the breakup result and the symptoms?	Ocular surface sections
12	COMP / DIFF (if a prior exists)	Same eye, same scale, same zone, same reference? Does the change exceed repeatability?	Comparison and progression
13	Everything together	What pattern emerges, what else could explain it, and what examination comes next?	Worked examples; Practitioner workflow

03 Clinical question, scope and how to use the reference categories

Clinical question. A practitioner holds a CA-800 printout or screen and needs to know what a field measures, whether the number can be trusted, what population or instrument context applies to it, and what the report cannot tell them.

Scope. This guide covers the report families and clinical fields documented for the reviewed CA-800 software. Hardware generation, regional licence, installed lens database and i-MAP version may expose different layouts or omit modules. Tear meniscus height acquisition is specified from hardware version HW2; toric IOL calculation is an optional module. No sample reports from any particular unit were supplied for this edition, and no CA-800 keratoconus index, software version or ring-count statement beyond those on the manufacturer's public product page has been independently confirmed.

Exclusions. The guide does not cover instrument operation, servicing, calibration mechanics beyond what a reader needs to judge report validity, or the clinical management of any condition discussed.

Every reference value in this guide belongs to one of three categories. The category determines how much weight the value can carry.

Reference category	Meaning	How to apply it
Device-defined	A field or calculation documented in the CA-800 manual	Its name, unit and sampling zone should match the installed software. Confirm against the installed version before applying a threshold
Clinical reference	A typical value or a threshold supported by broader clinical evidence, often from a different population or instrument	Useful for orientation. It is not automatically a CA-800 reference interval and should be labelled with its source when recorded
No validated cutoff	No universal numerical normal/abnormal boundary established in the reviewed sources	Use quality, morphology, within-eye trends and the instrument's own classification. Do not invent a cutoff, and do not import one from another device

Sources: [1] §§13–17; [2]; [20].

04 Every documented report family

A printed report may contain only a selection of what is visible on screen. Save supplemental screens when they explain a decision, especially the KC/CLMI tabs, asphericity details and dynamic graphs.

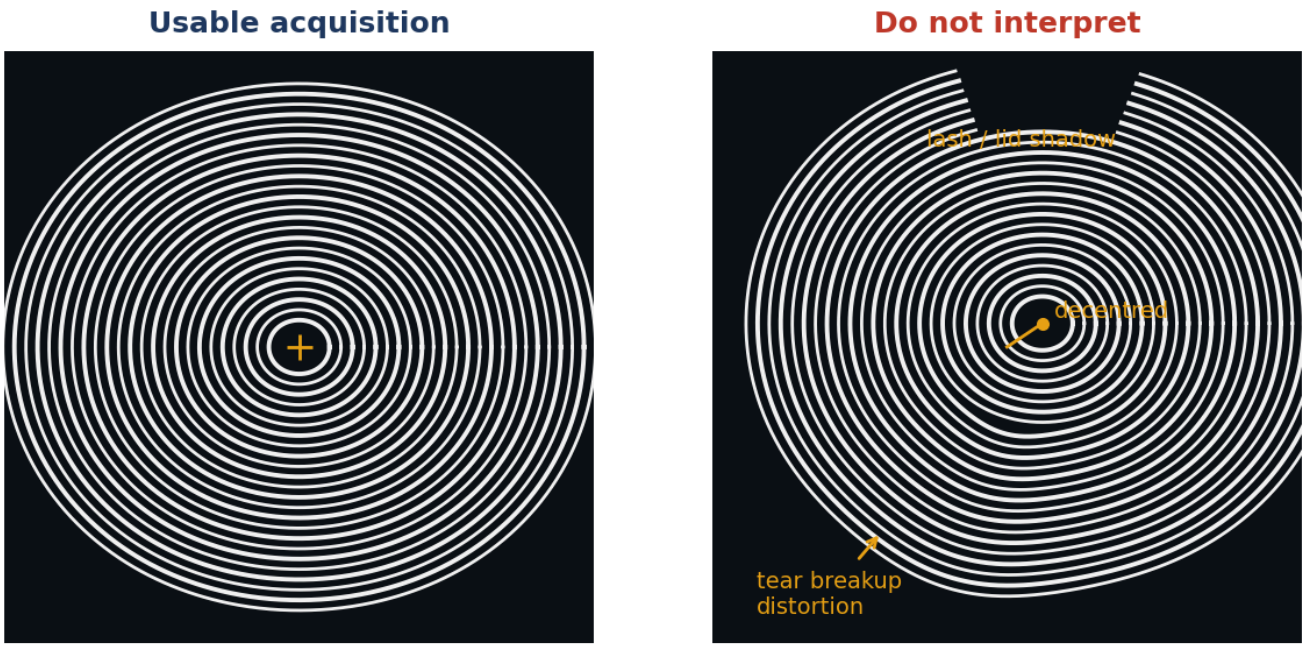
Report	What it contains	What it is used for
Corneal map	MAP; K, I, KC/AK and P tabs; OD/OS view	Shape, corneal astigmatism, irregularity and ectasia screening
Comparison map	COMP / DIFF; current and prior examination	Location and magnitude of change under matched settings
Contact lens	Lenses: Gallery, Ref, K/L, T/D, Profile	Geometric simulation and selection of trial lens parameters
Height map	HEIGHT; reference surface, fit diameter, profile, 3D	Anterior surface departure from a mathematical reference
Zernike analysis	ZER; maps, coefficients and optical simulations	Anterior corneal contribution to optical aberrations
Pupillometry	PUP; dynamic, photopic, mesopic, scotopic	Pupil diameter, position and response to illumination
Toric IOL	Optional lens calculation module	Planning calculation using measured K plus external inputs
Screenshot	Current display; also useful for WTW or extra graphs	Preserves settings and images omitted from standard reports
NIBUT / TBT	TBT Summary, single acquisition, maps, Blink	Tear stability and blink-related exposure
Meibomian gland	MEIB image and selected analysis area	Visible gland morphology and percentage area of loss
TMH	Tear meniscus image, calipers and profile statistics	Inferior tear reservoir height
Fluorescein	FLUO photographs or selected video frames	Ocular surface staining and observed contact lens fit

The height, comparison and contact-lens reports are available from their corresponding environments. Select the eye, report type and export destination deliberately, and inspect the resulting PDF for legibility and the acquisition date. White-to-white and blink analysis are documented functions even where they are not separate print-menu entries.

The manufacturer's public specification describes the CA-800 as a 24-ring Placido system measuring 6,200 points and analysing more than 100,000, with coverage up to 9.8 mm on an 8.00 mm radius sphere, and lists corneal wavefront analysis, tear-film breakup, tear meniscus height and blink analysis, meibomian gland analysis, four-condition pupillometry, contact-lens fitting simulation and white-to-white measurement among its functions. The page states no software version and names no keratoconus screening index; any index statement in this guide is therefore sourced to the manual, not the product page.

Sources: [1] §§14–17; [2]; [20].

05 Acquisition and quality control



Illustrative simulation of a Placido reflection image — not a patient acquisition

Figure 1 A usable Placido acquisition (left) shows sharp, continuous, correctly traced rings centred on the fixation target with adequate coverage. The acquisition on the right has a lash shadow removing peripheral rings, a local distortion from tear breakup and a decentred ring centre; any of these can create apparent steepening or irregularity. Illustrative simulation.

Check	What it means and why it matters	Expected value / clinical interpretation
Identity and context	Confirm patient, OD/OS, time, software version, test purpose, lens wear and prior surgery	A correct measurement attached to the wrong eye or baseline is clinically misleading
Calibration	Follow the supplied calibration tool workflow. Rev. 18 calls for daily checks and checks after transport, impact or thermal shock	Use the software pass/fail result. Instrument resolution is not a threshold for clinically real change
Tear-sensitive test order	Obtain non-invasive tear and topographic data before dye, anaesthetic, Schirmer strips or gland expression	Document recent drops, blinking instructions, environment and time since contact-lens removal
Raw Placido image	Look for sharp, continuous, correctly traced rings with adequate coverage of the region being interpreted	Lashes, eyelid shadow, mucus, breakup and poor fixation can create apparent steepening or irregularity
Repeatability	Acquire repeat acceptable scans when findings matter to diagnosis, surgery or progression	Inspect agreement of shape and axis, not merely whether the device selected a "best" frame
Missing data	Check lids and ring coverage before interpreting peripheral maps or large-pupil simulations	Blank or excluded regions are not normal findings. Interpolated display points are not independent measurements
Manual editing	Record edited ring points, limbus boundaries, pupil outlines or meibography regions	Reacquire when feasible. Editing should correct visible segmentation error, not make a result appear normal

Contact lenses and longitudinal measurements

There is no single washout interval suitable for every soft, rigid or orthokeratology lens. Record the lens design and removal time, and use a corneal specialist's stabilisation protocol for ectasia or surgical assessment. After orthokeratology, expected treatment-related flattening must be distinguished from the untreated baseline. In contact-lens wearers the CA-800 non-invasive breakup measurement and a subjective tearscope measurement are not interchangeable, and the published agreement work carries a subsequent correction; see the tear breakup section.

The acquisition checklist to file with every clinically consequential scan

- Calibration status at the time of capture.
- Number of acceptable repeat acquisitions and whether their shape and axis agreed.
- Ring coverage and any excluded region.
- Fixation quality and any surface artefact visible in the raw image.
- Time since lens removal, lens type, recent drops, and whether dye or anaesthetic had been instilled.
- Any manual edit to ring points, limbus, pupil outline or gland region.

> **Usable scan:** adequate focus + valid ring tracing + representative tear surface + appropriate coverage + reproducible result. A single impressive colour map cannot compensate for failure of these checks.

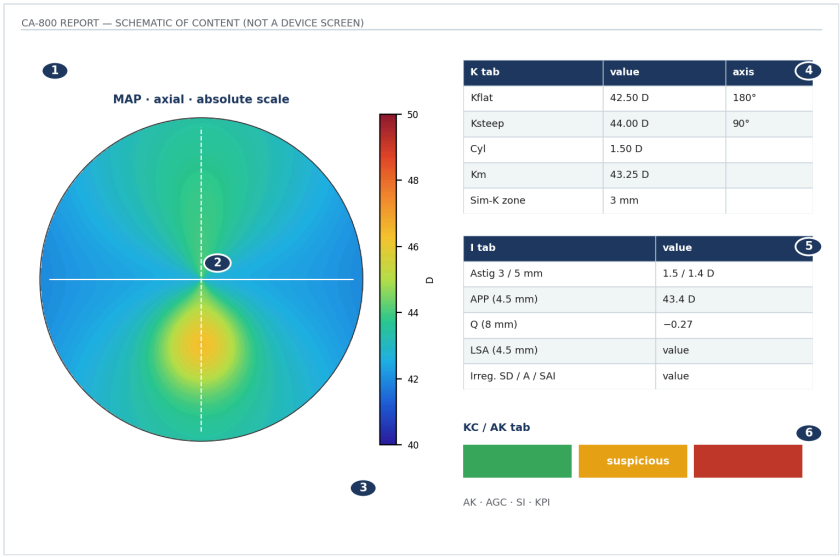
Sources: [1] §§13.2, 13.5–13.9, 14.1.10; [4]; [13–16].

06 Reading the corneal map

Figure 2 · The MAP report and its tabs

What the corneal map report contains, and where each field discussed in this section and the next three sits.

1. **Axial map** at the selected scale. Read the legend before the colour; confirm absolute versus normalised.
2. **Principal meridians**: flat (solid) and steep (dashed) as labelled in the K tab. 0° and 180° are the same meridian.
3. **Sampling rings** for the 3 / 5 / 7 mm or 2 / 4 / 6 mm zone display, depending on settings.
4. **K tab**: Kflat, Ksteep, cylinder, axis, mean K, Sim-K zone. Check which convention the axis label follows.
5. **I tab**: astigmatism at 3 and 5 mm, APP over the 4.5 mm zone, asphericity, LSA, irregularity SD, asymmetry and SAI. No manufacturer normal interval is published for these.
6. **KC / AK tab**: AK, AGC, SI and KPI with the software class. Read the class; the numerical boundaries are not documented.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

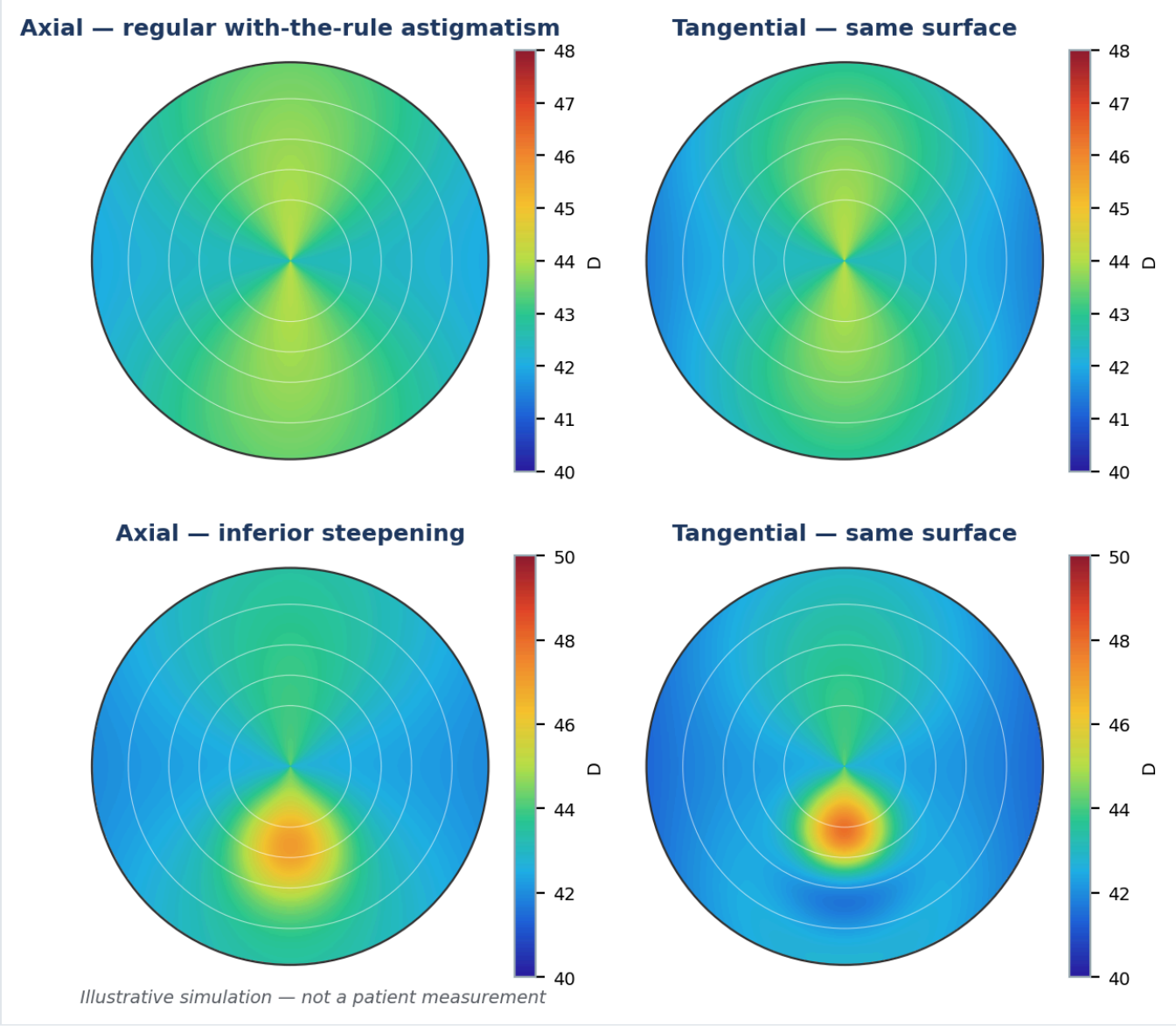


Figure 3 The same two simulated surfaces computed as axial (left) and tangential (right) maps. Regular with-the-rule astigmatism gives a symmetric bow tie on both; a focal inferior steepening looks broader on the axial map and sharper on the tangential. Illustrative simulation.

Placido topography reconstructs anterior surface shape from reflections on the tear-coated cornea. It does not directly image posterior corneal elevation or measure corneal thickness. A CA-800 height map remains an anterior-surface reconstruction.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Axial / sagittal map	Describes curvature with respect to the measurement axis. Useful for the overall pattern and regular astigmatism	Expected: a reasonably smooth, symmetric pattern; a regular bow tie can be normal. Axial maps can make a localised cone appear broader
Tangential / instantaneous map	Describes local curvature change. Helps localise focal steepening and treatment-zone boundaries	Expected: coherent, repeatable local shape. More sensitive to local noise, tracing errors and surface disturbance
Absolute scale	A fixed colour-to-value relationship	Use identical scale and unit across visits. A colour is meaningful only after its numerical legend is read
Normalised scale / step	Colours are fitted to the examination's range; step is the numerical interval per colour band	No physiological normal. A small step magnifies subtle variation; separately normalised maps can exaggerate apparent change

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Point D and r	Local dioptric power and curvature radius, typically D and mm	Smaller curvature radius means steeper power. These describe location-specific curvature, not spectacle refraction
Point angle and z	Meridian angle and reconstructed axial/altimetric coordinate	Check the display's origin and unit. Raw z is not automatically the same as the HEIGHT residual from a best-fit reference
Profile and 3D	Meridional curvature traces and a 3D rendering of the same reconstruction	Useful for explaining shape. Rendering does not add posterior-surface or thickness measurements

Patterns that deserve a second look

Reproducible inferior or inferotemporal steepening, an asymmetric bow tie, skewed radial axes, a displaced steep region, or new irregularity merit correlation with refraction and slit-lamp examination. A "crab-claw" pattern is not by itself diagnostic of pellucid marginal degeneration; tomography and peripheral examination may be needed. A pattern that appears on one capture and not on a good-quality repeat is, until proven otherwise, a tear-film or alignment effect.

Why a Placido map and a Scheimpflug map of the same cornea can disagree

A Placido system samples where the rings reflect, which is dense in the mid-periphery and sparse at the apex; a rotating Scheimpflug camera samples a slit section through the apex and infers the anterior surface from the corneal cross-section. Each reconstructs curvature through different geometry and smoothing. When a CA-800 map and a Pentacam, Sirius or Galilei map of the same eye differ in the location or magnitude of a steep region, the difference can arise from sampling, from the tear film at the moment of capture, or from genuine change between examinations. Do not adjudicate between them by picking the more alarming one; repeat the acquisition on the instrument that will be used for follow-up.

Sources: [1] §§13.6, 14.1, 14.4; [12–14]; [25]; [43].

07 Keratometry and astigmatism

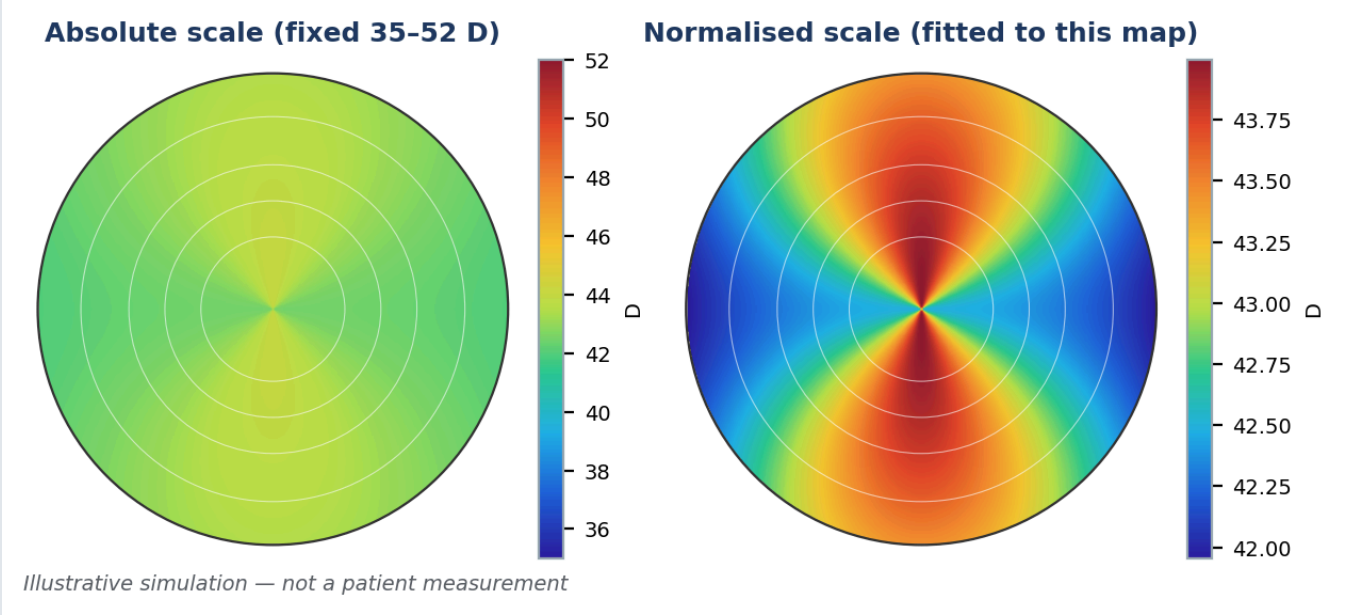


Figure 4 One simulated surface on an absolute scale and on a normalised scale fitted to this examination. The normalised display magnifies 1.5 D of regular astigmatism into a dramatic bow tie; separately normalised maps from two visits can exaggerate apparent change. Illustrative simulation.

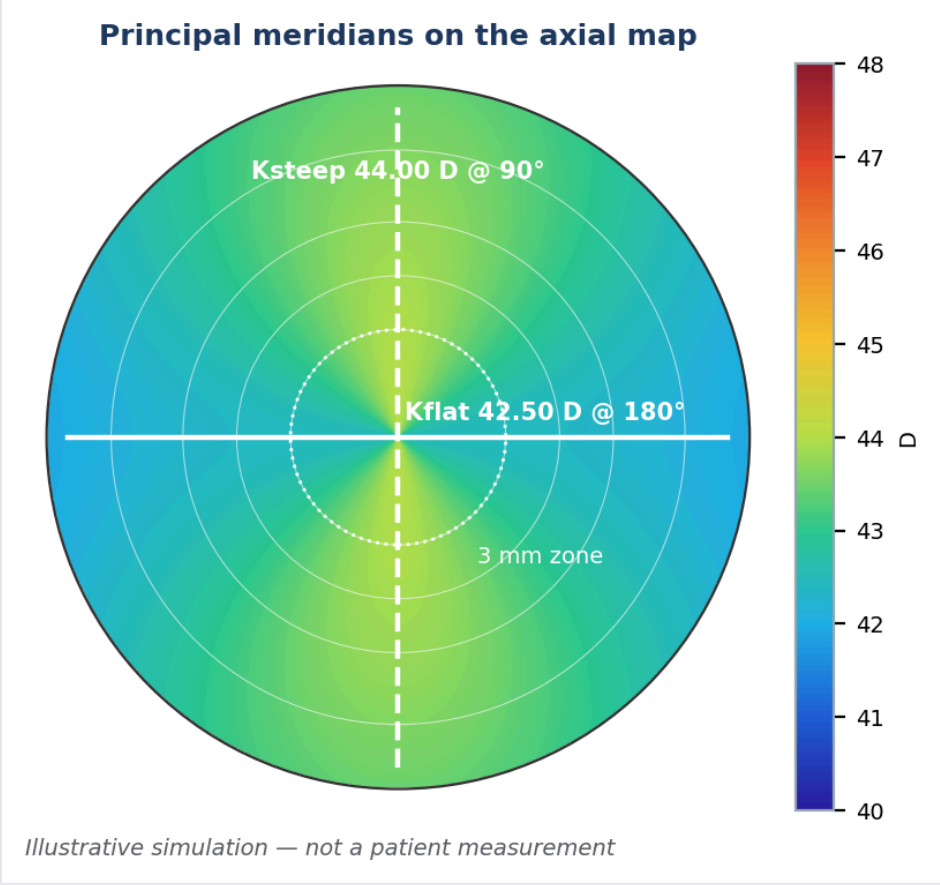


Figure 5 Principal meridians on the axial map for the worked example: Kflat 42.50 D at 180°, Ksteep 44.00 D at 90°, 1.50 D of anterior corneal cylinder, mean 43.25 D. Illustrative simulation.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
K1 / Kflat, D or mm	Flatter principal meridian. Its radius is larger than the steeper meridian's radius	Adult central K values are often around 43–44 D; roughly 40–46 D is a broad orientation range, not a validated CA-800 normal interval
K2 / Ksteep, D or mm	Steeper principal meridian. Compare with K1 and examine the map	Higher values indicate greater curvature, not necessarily disease. A normal central K does not exclude a peripheral or early cone
Mean K / Km, D	A central average when provided; commonly related to the two principal powers	Use the software definition. Averaging radii then converting to D differs slightly from averaging powers
Cylinder / Cyl, D	Magnitude of corneal astigmatism, conventionally Ksteep minus Kflat; printed sign may follow plus- or minus-cylinder settings	Zero means no difference between principal powers. Regular non-zero cylinder is common and is not itself keratoconus
Axis, degrees	Orientation of the meridian or cylinder convention named in the report	0° and 180° represent the same meridian. Check whether the label denotes flat K, steep K, plus cylinder or minus cylinder
Sim-K	Simulated keratometry based on a central sampling region	Do not assume it equals every 3 mm zone value or another instrument's Sim-K. Match the selected mode in serial records
3 / 5 / 7 mm; 2 / 4 / 6 mm	Zone diameters for the meridian / emimeridian display, depending on settings	Peripheral values need adequate measured coverage. Comparing different diameters can change magnitude and axis without biological change
Meridians / emimeridians	Full principal-meridian analysis versus separate half-meridian values	Opposite halves can reveal asymmetry hidden in the combined value. Nasal/temporal labels depend on the eye

Worked example. Kflat 42.50 D at 180° and Ksteep 44.00 D at 90° give 1.50 D of anterior corneal cylinder and an arithmetic mean of 43.25 D. A steeper vertical meridian is a with-the-rule pattern. This does not prescribe the spectacle cylinder, which includes the rest of the eye's optics.

The keratometric index

Corneal power in dioptres on a topographer is a conversion from radius using an assumed refractive index, conventionally n = 1.3375: K(D) = 337.5 / r(mm). An 8.00 mm radius therefore reads 42.19 D. That index is a convention describing the whole cornea as a single refracting surface; it is not a direct measurement of both surfaces, and instruments or software using a different index will print different dioptric values for the same radius. When comparing K between devices, compare radii, or confirm that both use the same index.

Sources: [1] §§14.1.2, 17.3, 17.6; [5] supplies population context, not a CA-800 interval.

08 Keratorefractive indices

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Astigmatism at 3 and 5 mm	Corneal cylinder and axis calculated over two zones	A smooth regular cornea usually has broadly consistent orientation. A marked zone-dependent change may reflect irregularity, treatment geometry or artefact
APP / Pupil Avg, D; 4.5 mm zone	Average corneal power across a specified 4.5 mm pupil area. The word "pupil" names the averaging zone	Expected to be broadly compatible with central K in a regular untreated cornea. It is not pupil diameter or the patient's refractive error
Asphericity e / SF / p / Q	Shape descriptor indicating change in curvature from apex to periphery. The main index uses an 8 mm diameter	Normal untreated corneas are often prolate. See the asphericity section for notation and why values at 4.5 and 8 mm differ
LSA, D; 4.5 mm zone	Longitudinal spherical aberration: difference in focusing behaviour of rays across the specified corneal zone	No verified universal CA-800 cutoff. It is not interchangeable with a Zernike spherical coefficient or RMS in micrometres
Curvature Irreg., SD, D	Curvature irregularity statistic over the 4.5 mm region. The manual describes instantaneous-curvature variation and best-fit residual irregularity	Lower values generally indicate a more regular surface. No validated numerical threshold found; confirm the exact panel definition if comparing exports
Asymmetry A, D; directions	Difference between the more curved and flatter hemispheres in a 4.5 mm region. Associated power values and directions identify the contrast	Nearer zero suggests less hemispheric difference. A persistent larger difference warrants image review and clinical correlation
SAI, D in manual figure	Surface Asymmetry Index for the 4.5 mm area. A surface-symmetry measure distinct from KC-tab SI	Lower is generally more symmetric. Do not transfer a cutoff from another topographer's SAI, SRI or ISV

What an abnormal index contributes

Irregularity and asymmetry can explain ghosting or reduced best-corrected acuity even when mean K is ordinary. They can also be produced by tear breakup, scarring, epithelial disease, contact-lens warpage or prior surgery. Review the spatial pattern and repeat after controlling surface and acquisition factors before attributing it to ectasia.

"SAI" and "SRI" on other instruments are not the CA-800 SAI

The Surface Asymmetry Index and Surface Regularity Index were defined on the Tomey TMS series. As described in the literature, the TMS SRI quantifies power-gradient differences between successive ring pairs across 256 semi-meridians, and normal corneas are reported to present SRI values below about 0.56; the TMS SAI averages the power differences between points 180° apart across 128 meridians. The CA-800 manual's SAI is a 4.5 mm-zone asymmetry figure in dioptres. Equivalence between the CA-800 and TMS SAI implementations has not been established, and the reviewed manual does not publish the CA-800 formula; a TMS SRI or SAI threshold should not be transferred to the CA-800 field without validation.

Sources: [1] §14.1.3, including Figs. 44–46; [30]. Manufacturer numeric reference intervals for the CA-800 indices are not given in the reviewed manual.

09 Asphericity and peripheral geometry

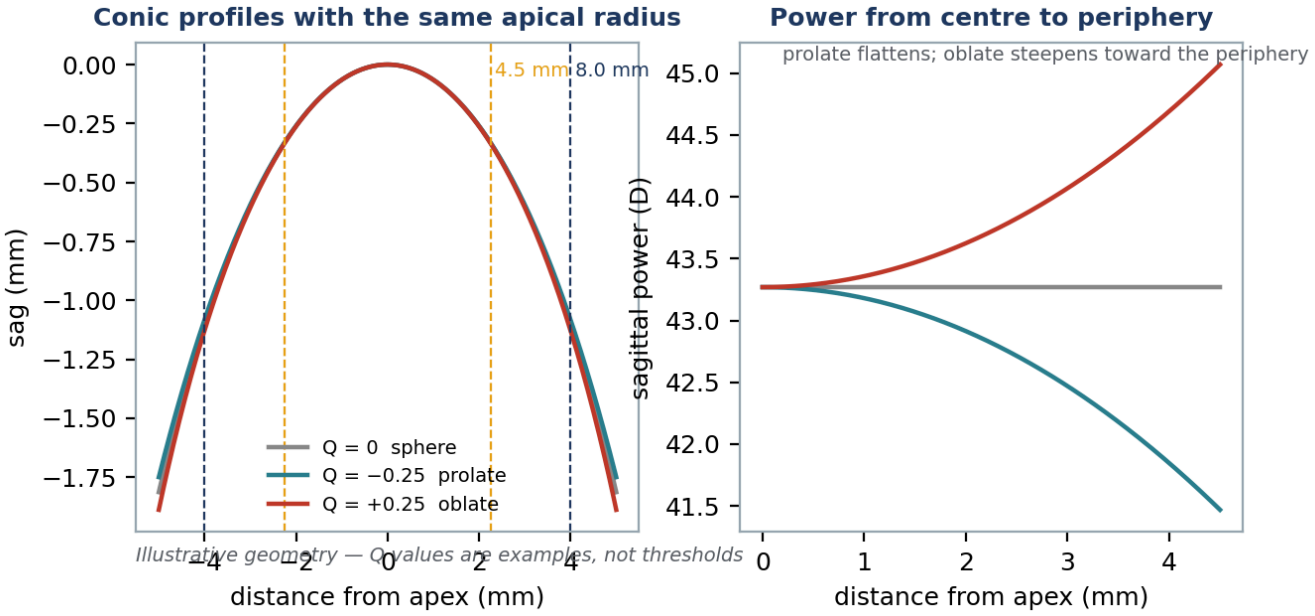


Figure 6 Left: three conic profiles with the same apical radius — Q = 0 sphere, negative Q prolate, positive Q oblate. Right: the corresponding change in sagittal power from centre to periphery. Values at 4.5 mm and 8 mm differ because they sample different zones. Illustrative geometry; the Q values are examples, not thresholds.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
R0 / Ro, mm or converted D	Fitted apical radius/power along the flat meridian, steep meridian and their average	It describes the apex of a fitted conic; it is not necessarily the map's steepest single point
Q, dimensionless	Conic asphericity: Q = 0 spherical, negative Q prolate, positive Q oblate under the usual convention	A useful central tendency is about –0.2 to –0.3 for an untreated anterior cornea. This is not a diagnostic interval or a CA-800 8 mm limit
e, dimensionless	Eccentricity, another expression of conic shape	For a conventional prolate ellipse, Q = –e². Example: e = 0.50 corresponds to Q = –0.25. Do not apply this conversion blindly to signed software conventions for oblate shapes
p and SF	Alternative shape notations selectable in CA-800 settings	In common conic notation p = 1 + Q, and SF may mean e² = –Q; the reviewed manual does not define its SF conversion. Confirm before converting or pooling values
8 mm principal meridian values	Fitted curvature, shape and meridian orientation over an 8 mm diameter	Broader sampling characterises peripheral flattening. Missing peripheral rings reduce confidence
4.5 mm values; pupillary asphericity	Corresponding central-zone fits and pupillary surface shape	Compare like diameter with like diameter. A central-zone Q is not a substitute for an 8 mm Q
R10, R15, R20, R25, R30	Peripheral-angle entries for nasal, temporal, inferior and superior half-meridians; horizontal, vertical and overall averages	Depending on settings, entries are eccentricity or sagittal radius. Read units rather than interpreting "R" alone. No universal normal for every sector
Surface SD	Departure of measured curvature from its associated aspherical fit	Lower residual irregularity is generally preferable. It is a fit statistic, not thickness or a direct measure of visual acuity

Asphericity is useful for understanding contact-lens alignment, orthokeratology changes and spherical aberration. A positive postoperative Q can be expected after myopic ablation or corneal reshaping and should not automatically be classified as disease. One healthy-eye study found anterior Q of –0.24 ± 0.10 at 6 mm using a Pentacam; that sampling and instrument differ from the CA-800 and the figure is population context only.

Sources: [1] §14.1.3 and §17.3; [6].

10 Keratoconus screening indices

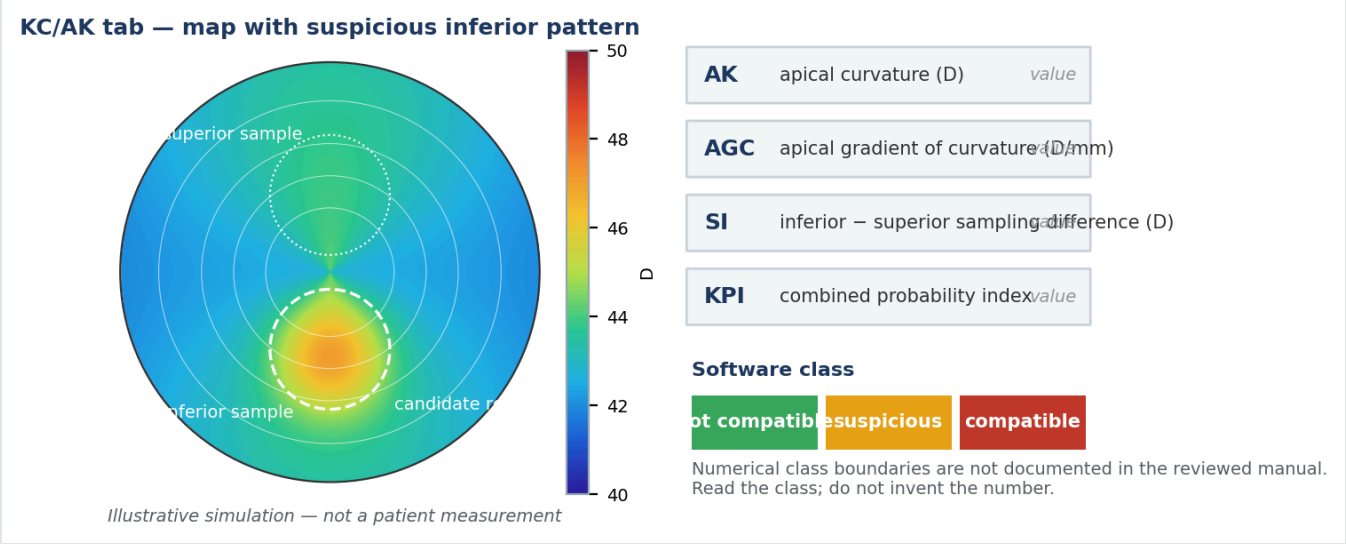


Figure 7 The KC/AK panel: AK, AGC, SI and KPI beside a map with a suspicious inferior pattern and the inferior and superior sampling regions the SI compares. The software class is the reading; the exact numerical boundaries between classes are not documented in the reviewed manual. Illustrative simulation.

This panel combines shape features to classify whether the anterior topographic pattern is compatible with keratoconus. The colour is an algorithmic classification of the acquired map, not a histological diagnosis or a percentage of tissue damage.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
AK, D	Apical curvature: corneal power at the apex	Contextually, ordinary central corneal power is reassuring, but AK has no stand-alone diagnostic cutoff verified in the reviewed manual. AK is not automatically Kmax
AGC, D/mm	Apical gradient of curvature: average change in corneal power per unit distance, referenced to apical power	A greater gradient can support focal steepening. No numeric CA-800 normal interval is published in the reviewed manual
SI, D	Difference between average powers in inferior and superior circular sampling regions positioned on the vertical axis	A value nearer zero represents less imbalance in those regions. Sign and magnitude matter. Do not equate it to a different instrument's I-S formula
Kpi / KPI, % on example display	Combined keratoconus probability index interpreted with AK, AGC and SI	Use the accompanying software class. Exact green/yellow/red numerical boundaries are not documented in the reviewed manual; do not invent them
Green class	Pattern classified as not compatible with keratoconus	Reassuring only within test sensitivity and scan quality; does not exclude early ectasia or posterior/thickness abnormalities
Yellow class	Pattern suspicious for keratoconus	Repeat good-quality scans, investigate lens warpage and surface disease, and consider corneal tomography or referral
Red class	Pattern compatible with keratoconus	Requires correlation with history, refraction, slit lamp and tomography. Prior surgery, scars or poor acquisition can affect classification

Do not substitute familiar cutoffs. K >47 D, I-S >1.4 D, KISA% >100, Pentacam BAD-D ≥1.6 or ≥2.6, the Belin/Ambrósio elevation-difference limits (posterior >16 µm), and other systems' SAI/SRI/ISV thresholds are not definitions of a positive CA-800 KPI. They arise from different parameters, algorithms, instruments and datasets. The section on cross-device indices explains each one and where it belongs.

A reasonable next step for a reproducibly suspicious map is specialist assessment with tomography and pachymetry, especially in a young patient, an eye with increasing irregular astigmatism, or before corneal refractive surgery.

The CA-800 class in the wider evidence picture

The 2015 Global Consensus on Keratoconus and Ectatic Diseases, as quoted in the 2025 literature reviewing it, agreed that abnormal posterior elevation and abnormal corneal-thickness distribution are mandatory to diagnose keratoconus, and that posterior elevation abnormalities must be present to diagnose mild or subclinical disease. A 2025 review of 29 studies concluded that the evidence does not in fact support the claim that posterior abnormalities must be present to diagnose subclinical keratoconus. An Edition 2 of the consensus was published in *Cornea* in 2026 with revised definitions; its specific diagnostic statements were not accessible for this edition and are not summarised here.

What this means at the CA-800: the device sees only the anterior surface, so whichever way the consensus debate settles, a CA-800 class is at most one component of an ectasia assessment. A red or yellow class earns tomography; a green class in a young patient with progressive astigmatism, a family history, or a refractive-surgery request does not close the question.

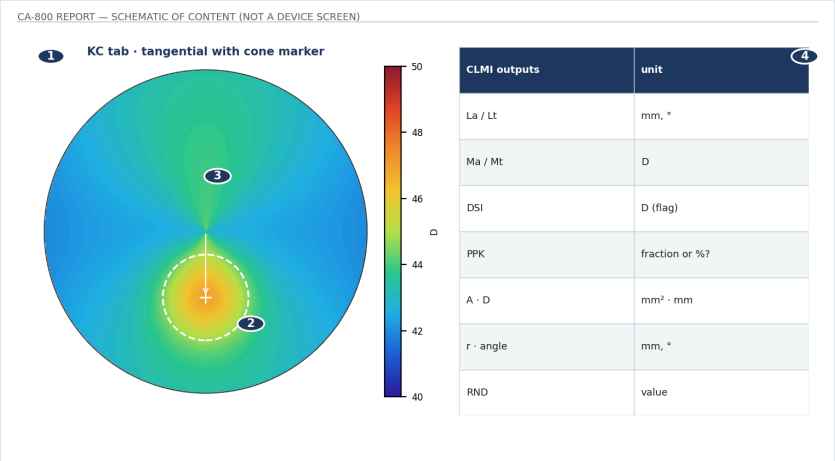
Sources: [1] §14.1.4; [12–14]; [32]; [33].

11 Cone location, magnitude and shape (CLMI)

Figure 8 · The CLMI outputs

How the cone-location fields relate to the map.

1. **Tangential map** on the KC tab; CLMI searches this and the axial map for a localised steep region.
2. **Candidate region** with its barycentre: La/Lt give its location, Ma/Mt its magnitude relative to the surrounding map.
3. **r and angular coordinate** of the barycentre from the map centre; distinguish this r from curvature radius.
4. **Output table**: DSI, PPK, area A in mm², diameter D in mm (not dioptres), RND. None carries a normal limit in the reviewed manual.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
La / Lt, mm and degrees	Location of the candidate steep region in axial (a) and tangential (t) analyses	No normal location threshold. A location becomes clinically meaningful when the associated magnitude and pattern suggest a cone
Ma / Mt, D	Axial and tangential CLMI magnitude measures describing localised steepening relative to the surrounding map	A more pronounced focal contrast can strengthen suspicion. Axial and tangential magnitudes are not interchangeable
DSI, D on manual figure	Differential Sector Index. The reviewed manual supplies its name but not the full formula or a numerical normal limit	Retain the exact label, value and flag. Do not reinterpret it using an unrelated system's differential-sector calculation
PPK	Percent Probability Keratoconus associated with CLMI	A model-derived screening output. Verify whether the software displays a fraction or a percent before transcribing; the manual example lacks an explicit % suffix
A, mm²	Area of the algorithm-identified cone, shown when the KC pattern is suspicious or compatible	No healthy target or validated disease-stage boundary. It tracks the region identified by this algorithm, not histological lesion area
D, mm	Average diameter of the identified cone	No general normal range. Do not confuse this D with dioptres; the printed unit resolves the ambiguity
r and angular coordinate	Distance and direction of the cone's barycentre relative to the map centre	Location aids reproducibility and lens planning. Distinguish this r from curvature radius and from CLMI's candidate-region location
RND	Circularity factor of the identified cone	Describes shape. The reviewed manual does not specify a normalised scale or a diagnostic limit; do not assume that "1" is the required normal value

How much evidence does CLMI add?

The original CLMI research sought localised steepening on axial and tangential maps and tested discrimination on Keratron and TMS-1 datasets. Its published performance cannot be treated as a prospective validation of every CA-800 software version or of subclinical disease. Later work on CLMI-X and zonal Kmax in keratoconus progression describes repeatability for those specific implementations, which are not the CA-800 CLMI. Report the map pattern, classification and clinical corroboration together.

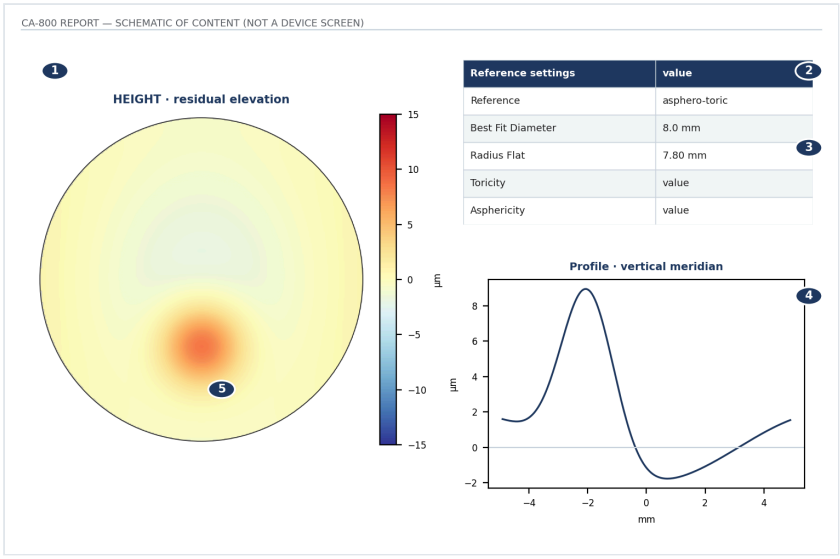
Sources: [1] §14.1.4, Figs. 47–48; [12]; [14].

12 Height and elevation reports

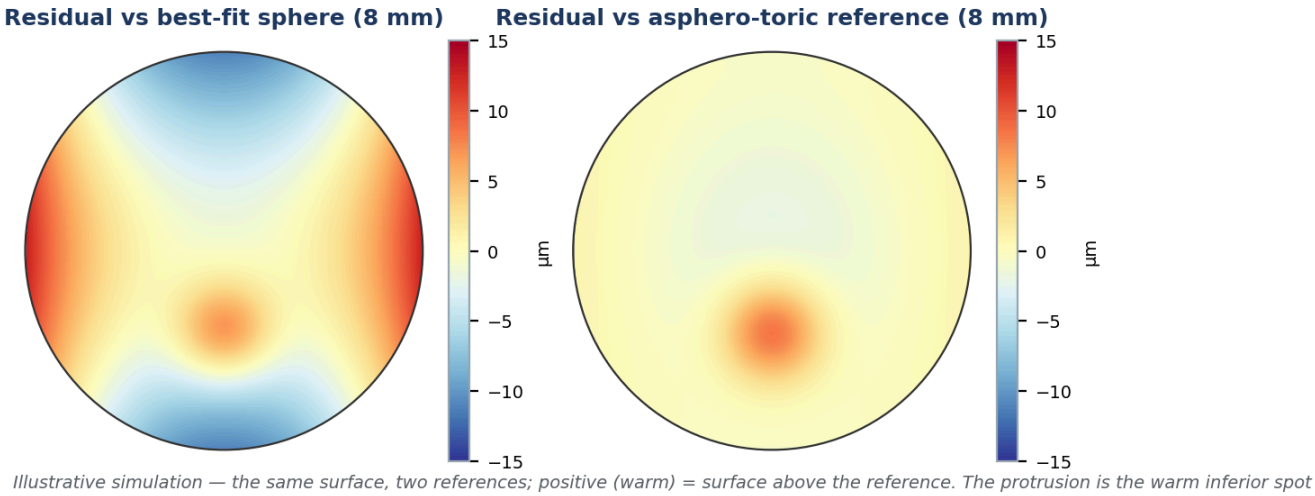
Figure 9 · The HEIGHT report

What the elevation report contains and which settings determine the residual.

1. **Residual elevation map** in µm: signed distance between the reconstructed anterior surface and the selected reference.
2. **Reference surface**: spherical, aspherical or asphero-toric. Residuals are not comparable across references.
3. **Best Fit Diameter** and the reference parameters (Radius Flat, toricity, asphericity). Record the same diameter across visits.
4. **Profile** along a chosen meridian; the plotting scale (5, 10 or 50 µm) is a display choice, not a severity category.
5. **Point readout**: r and angle here are map coordinates, not curvature radius.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.



Illustrative simulation — the same surface, two references; positive (warm) = surface above the reference. The protrusion is the warm inferior spot

Figure 10 One simulated surface — regular toricity, mild asphericity and a small focal protrusion — fitted against a best-fit sphere (left) and an asphero-toric reference (right) over 8 mm. Positive (warm) values are surface above the reference, so the protrusion appears as the warm inferior spot. The spherical fit leaves the toricity as a bow-tie residual that hides it; the asphero-toric fit exposes it. Same eye, same scan. Illustrative simulation.

A height report answers: **how far does the reconstructed anterior surface depart from the chosen reference surface?** It does not answer how thick the cornea is. Changing the reference changes the residual elevation even if the eye has not changed.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Height / elevation, usually µm	Signed distance between the reconstructed anterior surface and a corresponding reference-surface point	Near-zero residual means close to the selected fit. There is no universal ±µm normal limit independent of fit diameter, surface and instrument
Spherical reference	Best-fit or user-adjusted sphere; Radius Flat controls radius	Useful for displaying departures from a simple sphere. Regular astigmatism can create substantial residuals
Aspherical reference	Conic surface with radius and asphericity parameters	Accounts for normal peripheral shape change. Residuals are not directly comparable with a spherical reference
Aspheric-toric reference	Reference incorporating radius, toricity and asphericity	May remove regular toricity and expose remaining irregular shape. A smaller residual partly reflects the more flexible fit
Best Fit Diameter, 3–8 mm	Area used to estimate the reference surface	No physiological normal. Record the same diameter across serial analyses; a larger or smaller fit area changes the residual pattern
Radius Flat / Toricity / Asphericity	Parameters defining the fitted or manually adjusted mathematical reference	These are reference-model parameters, not independent measurements of posterior cornea or stromal integrity
Point r and angle	Radial distance from image centre and angular position of the selected point	Coordinates localise the residual. Here r is a map position, not the curvature radius on the MAP screen
Profile / 3D / Differential	Meridional traces, surface rendering, or comparison with a prior reconstruction	Inspect scale and reference consistency. Profile display choices of 5, 10 or 50 µm are plotting scales, not clinical severity categories

Clinical significance. A reproducible localised protrusion may support an irregular anterior-surface finding. Ectasia assessment still requires information not captured here, especially posterior shape and corneal thickness distribution. Never apply a Pentacam posterior-elevation threshold to this report.

Why the Pentacam elevation thresholds do not travel

The OCULUS Pentacam interpretation guide gives colour limits for the **elevation-difference charts** of the Belin/Ambrósio Enhanced Ectasia Display — the change in elevation between the standard best-fit-sphere map (8.0 mm zone) and the enhanced-reference map that excludes the thinnest region: anterior <5 µm green, 5–7 µm yellow, >7 µm red; posterior <12 µm green, 12–16 µm yellow, >16 µm red. These are not limits for raw elevation above a best-fit sphere. They are defined for a difference between two specific reference surfaces, on Scheimpflug data, for both surfaces, on the Pentacam's reconstruction. The CA-800 HEIGHT report is a single **anterior** residual from Placido reflection against whichever reference the operator selected at whichever fit diameter. Nothing in it corresponds to the Belin/Ambrósio difference parameter, and a 16 µm anterior residual on a CA-800 asphero-toric fit at 6 mm carries no relationship to the Pentacam red band.

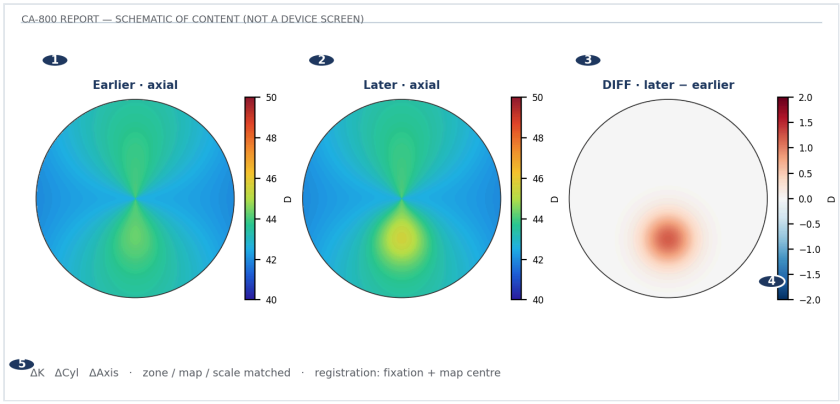
Sources: [1] §14.4; [13–14]; [25].

13 Comparison and progression

Figure 11 · The COMP / DIFF report

What the comparison report contains.

1. **Earlier examination** — verify the same eye and the intended baseline.
2. **Later examination** — same map type, zone, scale and step as the earlier one.
3. **Difference map**: pointwise later minus earlier. In dioptres, positive is steepening; in millimetres of radius the sign reverses.
4. **Legend and unit** of the subtraction — read before the colour.
5. **Delta values** for K, cylinder and axis, and the registration and coverage conditions the comparison depends on.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

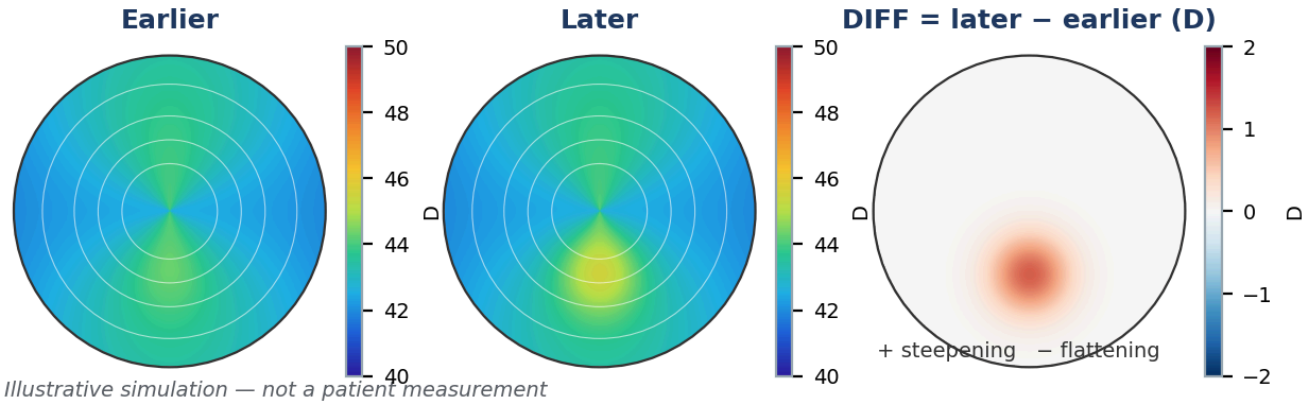


Figure 12 Earlier and later simulated axial maps and their difference map (later minus earlier, D). Illustrative simulation.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
OD/OS comparison	Both eyes displayed side by side	Useful for symmetry. The manual disables DIFF across fellow eyes; treat interocular comparison separately from longitudinal subtraction
COMP	Current and selected prior examination for the same patient	Verify that both maps refer to the same eye and that the intended baseline is selected
DIFF / difference map	Pointwise difference between two selected topographic examinations	Read the subtraction order and units. Under "later minus earlier" in D, positive means steepening and negative means flattening
Difference in radius	Change displayed in mm rather than D	Sign reverses its curvature implication: a larger radius means flatter power. Do not interpret every positive colour as steepening

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Delta K / cylinder / axis	Changes in matching numerical fields	No universal clinically significant threshold for all CA-800 parameters. Changes must exceed repeatability and be consistent with morphology
Zone / map / scale	Sampling diameter, axial versus tangential computation, and legend	Match these before comparing. Changes of pupil size also invalidate a simple comparison of aberration RMS
Registration / coverage	Fixation, map centre, head position and included corneal region	A shifted treatment zone or apparent peripheral change may come from alignment or coverage differences

What can be concluded from a repeat examination?

Repeated anterior steepening or increasing irregularity can raise concern for progression. A single colour change, a one-time index shift, or a change equal to display resolution cannot establish it. Use repeated high-quality measurements, symptoms, refraction and visual acuity; add tomography and pachymetric assessment when evaluating ectasia.

After cross-linking, laser surgery or orthokeratology, interpret the result against that intervention's expected course. Early remodelling, lens wear and tear instability can confound the comparison. A flatter anterior map alone does not establish restored biomechanics or complete disease stability.

The CA-800 manual does not publish a repeatability figure for its curvature outputs in the reviewed sections, and no peer-reviewed CA-800 topographic repeatability study was identified for this edition. Until one is available, obtain two or three acceptable acquisitions at each visit as a quality check: if they disagree with one another, a between-visit difference of similar size cannot be interpreted. The same-visit spread is not a statistical threshold for progression, because it does not capture variability from visit conditions, operator, alignment and surface state. Progression requires a change that exceeds appropriately established measurement variability, is reproduced on repeat, and is supported by clinical findings.

> **Illustrative wording:** "Repeatable inferotemporal steepening is present on matched tangential maps. Corneal tomography and clinical progression assessment are warranted; anterior topography alone does not establish the full ectasia profile."

Sources: [1] §§14.2, 14.5; [13–14].

14 Zernike coefficients and aberrations

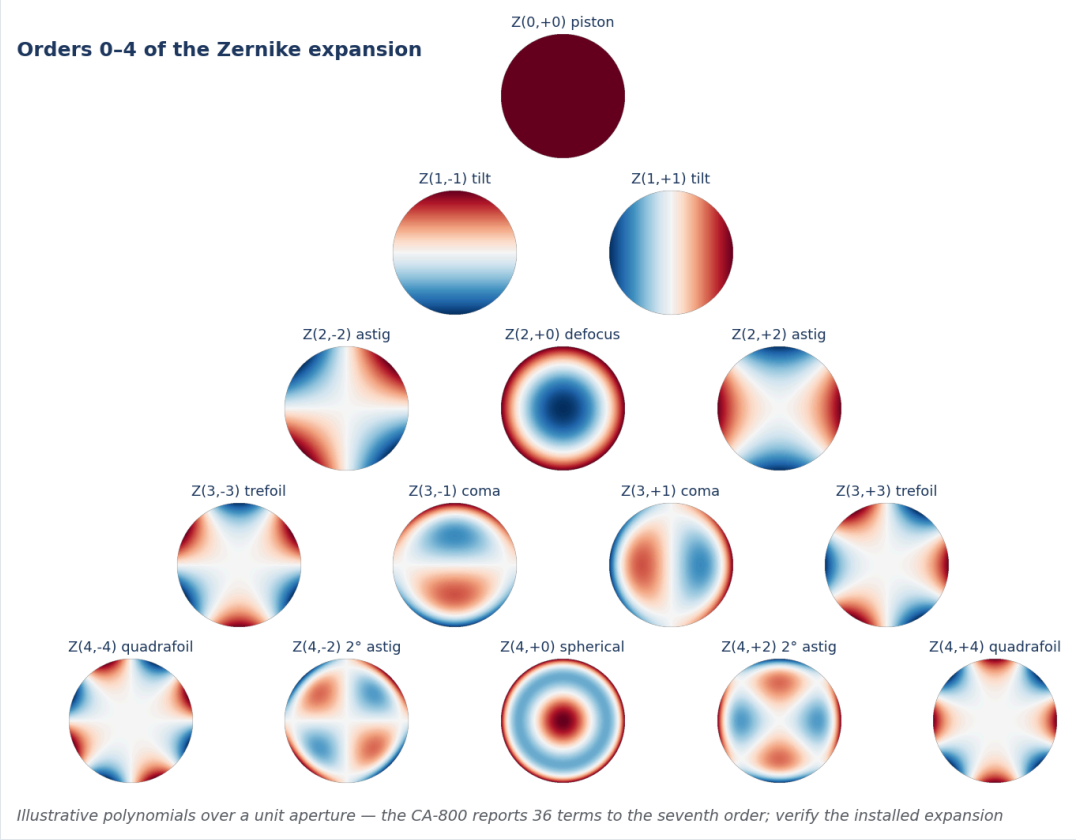


Figure 13 Orders 0–4 of the Zernike expansion over a unit aperture. Piston and tilt are reference terms; defocus and astigmatism are lower-order; coma, trefoil and spherical aberration are the higher-order terms most often discussed. The manufacturer brochure describes a 36-polynomial, seventh-order implementation; verify the installed expansion.

Zernike analysis expresses wavefront error as a sum of mathematical components. The CA-800 derives these from the **anterior cornea**. It does not directly measure the crystalline lens, posterior corneal contribution, retinal function or the entire eye's wavefront.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Analysis pupil, 2–7.5 mm selectable	Aperture over which the corneal wavefront is analysed	A setting, not a healthy-eye target. Larger apertures commonly expose more aberration. Always state diameter with an RMS value
Zernike coefficient, usually µm	Signed amplitude of one polynomial; identified by radial order n and angular frequency m or a software index	Zero means absence of that modelled component, not necessarily the ideal value for the whole eye. Verify normalisation and indexing when comparing systems
Order 0 piston; order 1 tilt	Constant optical-path offset and first-order wavefront tilt	Reference/alignment terms. Their inclusion or removal changes what "total" describes; they are not disease severity scores
Order 2 defocus; astigmatism	Lower-order focusing error and meridional power difference; astigmatism has paired oriented components	Non-zero values are common. Corneal-derived defocus/astigmatism cannot replace manifest refraction
Order 3 coma	Asymmetric aberration; paired horizontal/vertical components	An increased repeatable coma pattern can explain directional smearing or monocular ghosting. No universal CA-800 diagnostic µm limit

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Order 3 trefoil	Threefold asymmetric aberration represented by paired components	Can contribute to complex image distortion. Interpret magnitude at a fixed aperture and in context of other terms
Order 4 spherical Z(4,0)	Rotationally symmetric primary spherical aberration; signed coefficient differs from its non-negative RMS	A normal anterior cornea need not have zero spherical aberration; internal optics can partly compensate it
Other order 4–7 terms	Secondary astigmatism, quadrafoil and higher terms when included in the displayed expansion	No validated individual normal limits identified. High-order terms become vulnerable to missing coverage and noise

RMS. With orthonormal coefficients and the same included terms, RMS is the square root of the sum of their squared amplitudes. It is non-negative; the sign of an individual coefficient carries directional/shape information that RMS discards.

Population context for anterior corneal aberrations

One frequently cited study of 228 eyes measured anterior corneal aberrations with a Placido topographer (Humphrey Atlas) over the central 6.0 mm zone and reported mean higher-order RMS (third to sixth order) of 0.479 ± 0.124 µm, spherical-aberration RMS of 0.281 ± 0.086 µm (the fourth- and sixth-order terms combined, Z(4,0) and Z(6,0)) and coma RMS of 0.248 ± 0.135 µm (third- and fifth-order terms combined), with the primary spherical coefficient Z(4,0) positive in every cornea (0.280 ± 0.086 µm) and higher-order and coma RMS increasing with age. Those values describe that instrument, that aperture and that population. They are useful for judging whether a CA-800 figure is in an ordinary range for its aperture, and useless as a pass/fail line; the CA-800 aperture, term set and normalisation must all be checked before any such comparison, and a CA-800 primary-coma or primary-spherical coefficient alone should not be compared with these combined-order RMS values.

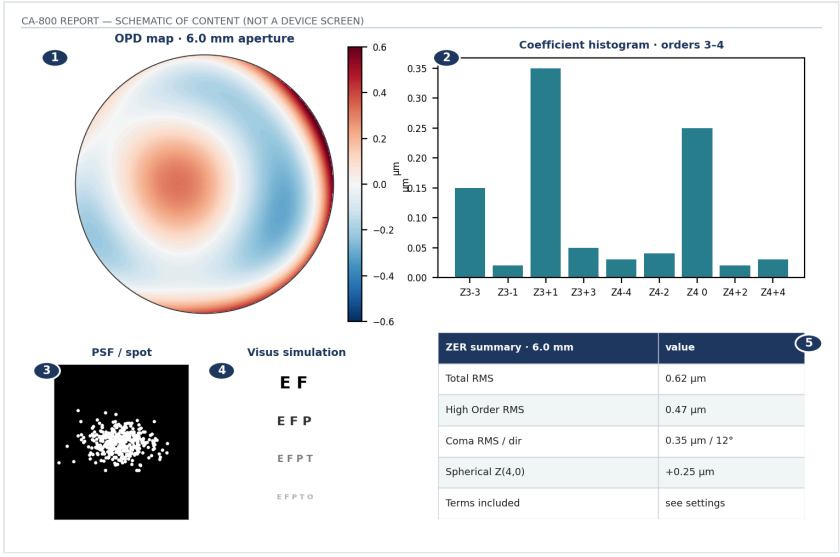
Sources: [1] §14.3; [3] describes the 36-polynomial, seventh-order implementation; [35].

15 Optical quality: what the displays mean

Figure 14 · The ZER report

What the optical-quality displays contain.

1. **OPD map** at the stated analysis pupil; the aperture is a setting, not a target.
2. **Coefficient histogram** by order and index; verify normalisation and indexing before comparing with another system.
3. **PSF / spot diagram** modelled from the anterior-corneal calculation. No validated pass/fail range.
4. **Visus simulation** — an illustration of anterior-corneal degradation, not measured acuity.
5. **Summary values**: total and high-order RMS, coma RMS and direction, spherical coefficient. Which terms are included determines what "total" and "High Order" mean.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

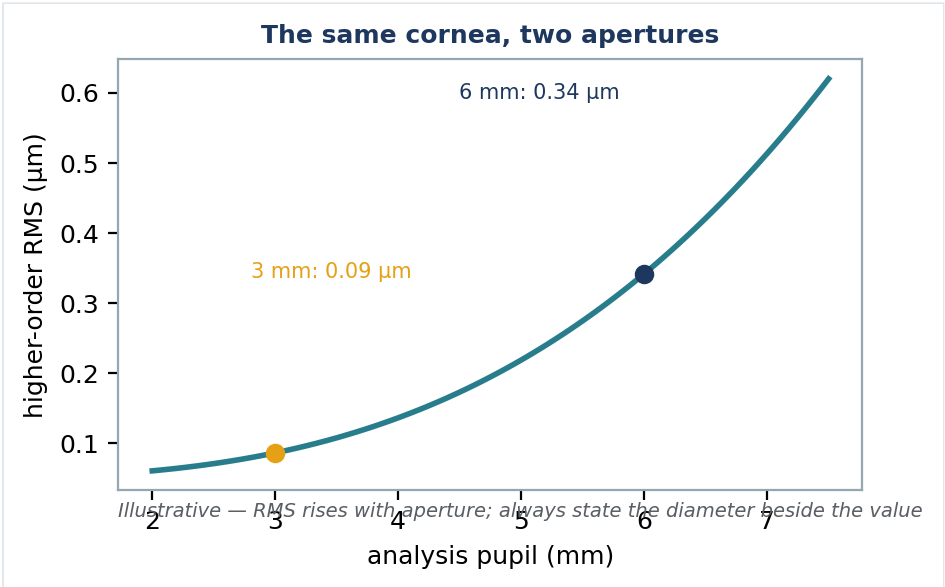


Figure 15 Higher-order RMS for one simulated cornea analysed at increasing pupil diameters: 0.09 µm at 3 mm, 0.34 µm at 6 mm. A follow-up value is comparable only at the same aperture. Illustrative.

Display	What it means and why it is used	Expected value / clinical interpretation
OPD map / total RMS, µm	Optical path difference across the selected aperture and its aggregate deviation from the chosen wavefront reference	Lower residual error generally favours sharper optics. "Total" depends on the included terms and software reference; no universal CA-800 normal cutoff

Display	What it means and why it is used	Expected value / clinical interpretation
Astigmatism map	Magnitude in D, axis and associated RMS	Corneal astigmatism may be regular and correctable. D and RMS are different descriptions, not numerically interchangeable
Spherical map	Longitudinal spherical aberration in D and associated RMS in µm	Interpret using the stated diameter. Do not compare 0.60 D of LSA with 0.60 µm of RMS as if equal
Coma map / direction	Combined coma effect, its RMS and orientation	A persistent large contribution supports asymmetric optical distortion. Direction can help identify a decentred optical pattern
High Order map	Software grouping of residual components beyond its named primary groups	The manual's "High Order" wording is not identical to an explicit "all n ≥ 3" definition. Confirm included terms before comparing with another device's HOA RMS
Coefficient histogram / pyramid	Magnitude and distribution of Zernike components; contrast encodes coefficient size	A visual summary of the same reconstruction. It is not an additional independent diagnostic test
PSF / spot diagram	Modelled point spread and ray distribution at the image plane from the anterior-corneal calculation	A compact point/spot is optically favourable. There is no validated CA-800 PSF pass/fail range
Visus / low-contrast ETDRS or Landolt C	Simulated high- or low-contrast target degradation	Educational illustration, not measured best-corrected acuity or contrast sensitivity. Retina, lens, scatter and neural processing alter actual vision

A useful paired comparison

Analyse the same good-quality scan at a smaller and a larger aperture to explore whether the anterior corneal optics plausibly contribute to night symptoms. For treatment follow-up, use the same aperture, centre and coefficient definition on both visits. If symptoms exceed the corneal explanation, examine tear dynamics, lens opacity, refraction and the posterior segment.

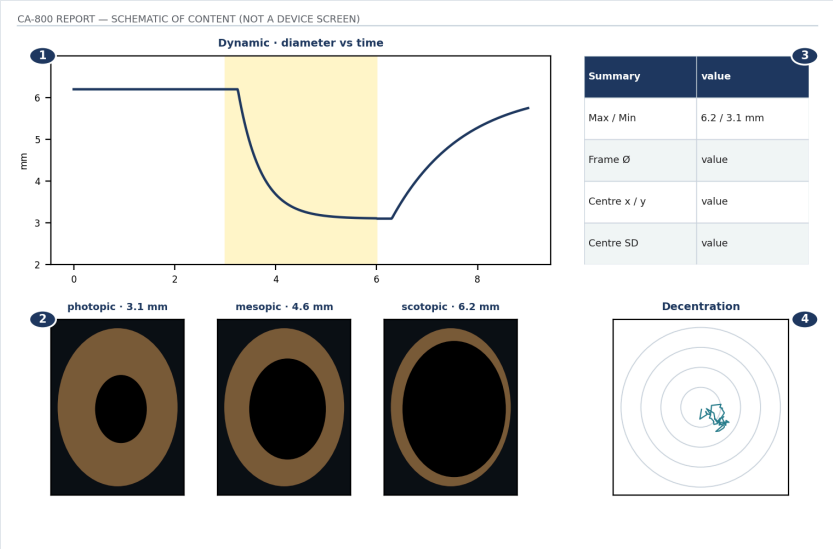
Sources: [1] §14.3. No universal CA-800 HOA, coma, PSF or simulated-acuity reference interval was verified.

16 Static and dynamic pupillometry

Figure 16 · The PUP report

What the pupillometry report contains.

1. **Dynamic graph**: diameter through dark, light-on and light-off phases; phase durations are programmable (500–5,000 ms in Rev. 18).
2. **Condition images**: photopic, mesopic and scotopic frames with the mean diameter for each.
3. **Summary**: maximum and minimum, frame diameter, pupil-centre x/y and its SD. The “Average” heading in Rev. 18 does not mean every value is an arithmetic mean.
4. **Decentration graph**: pupil-centre trajectory relative to the fixation reference; not a direct angle-kappa measurement.



Schematic of the report’s documented content drawn from the manual’s field list; values are illustrative and the layout is not a reproduction of the device screen.

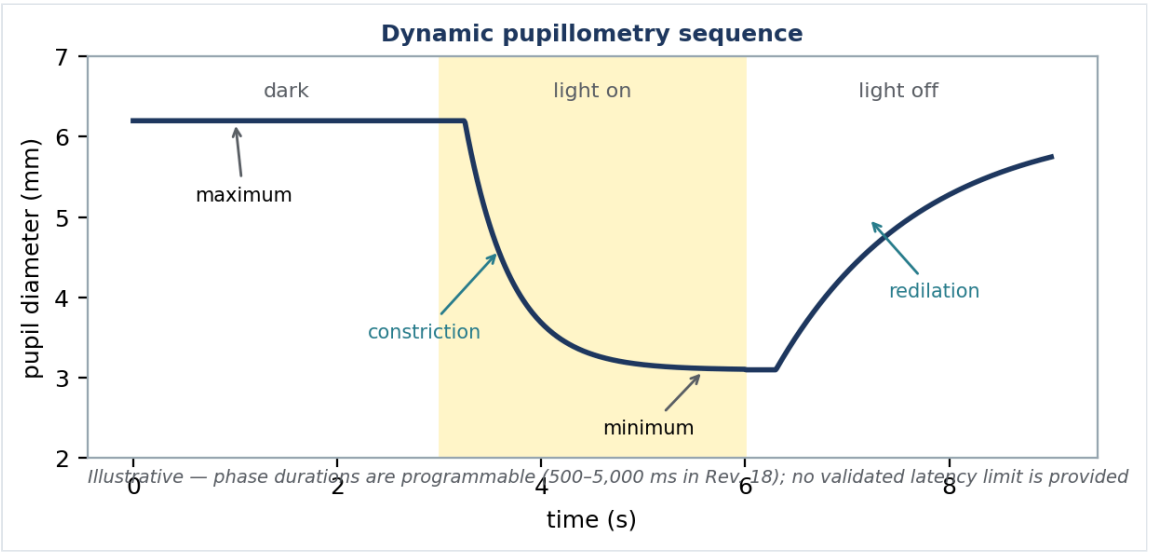


Figure 17 A dynamic pupillometry sequence with constriction and redilation annotated. Illustrative; no validated CA-800 latency or velocity limit was verified.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Photopic / mesopic / scotopic diameter, mm	Mean pupil diameter across frames in a bright, intermediate or dark acquisition condition	Expected direction: photopic smaller than mesopic and scotopic. Absolute diameter depends on age, illumination, adaptation and medication
Dynamic maximum / minimum, mm	Largest and smallest pupil diameters during the illumination sequence	Quantifies excursion under that protocol. Rev. 18 uses an "Average" panel heading for this summary; do not assume every value is an arithmetic mean
Frame diameter, mm	Pupil size at the currently selected frame	A time-specific observation, not the sequence average. A blink or boundary error can create an outlier

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Pupil centre x / y, mm	Cartesian position of the pupil centre for the sequence summary or selected frame	No universal healthy x/y cutoff. Read the reference origin and axis directions rather than equating this with anatomical visual-axis measurement
Pupil-centre SD, mm	Variation in pupil-centre coordinates across the acquisition	Small variation may reflect stable fixation; greater variation can reflect movement, physiological change or edge-detection error
Decentration graph	Trajectory of the pupil centre relative to the fixation reference, with concentric distance guides	Useful for pupil/optical-zone alignment. It is not a direct angle-kappa, angle-alpha or strabismus measurement
Latency graph	Pupil diameter versus time through dark, light-on constriction and light-off redilation phases	The plot shows response dynamics. Do not assume a separately validated numerical latency or neurological score is provided
Statistics graph	Within-acquisition distribution: mean, 25th–75th and 10th–90th percentiles, plus outlying frames	These describe that patient's sampled frames. They are not age-matched population normative percentiles

Record room conditions, adaptation, medications and the programmed light/dark durations. Rev. 18 permits phase settings from 500 to 5,000 ms; changing them changes the observed response. In poorly tracked images, correct the acquisition before interpreting asymmetry or an abnormal curve.

Expected pupil values and significance

Feature	Expected reference or behaviour	Clinical significance / limitation
Bright / photopic	Often approximately 2–4 mm in adults	Broad orientation only. A smaller pupil in an older person can be physiological; medication and the exact stimulus matter
Intermediate / mesopic	Often approximately 3–6 mm	A wide overlapping range. Do not classify a patient from a label such as "mesopic" without knowing light level and adaptation
Dark / scotopic	Often approximately 4–8 mm	Larger apertures may expose peripheral corneal aberrations or exceed a treated optical zone. Size alone does not predict night-vision complaints
Constriction / redilation	Pupil becomes smaller with light and enlarges after its removal	Compare shape and timing under matched settings. No CA-800-specific diagnostic latency or velocity limit was verified
Anisocoria	Small stable differences can be physiological; roughly ≤1 mm is a common clinical heuristic	New, symptomatic, lighting-dependent or poorly reactive asymmetry requires clinical assessment. Magnitude alone cannot establish benignity
Centration	No single normal displacement limit	Consider pupil size, optical-zone position, symptoms and the procedure or lens design. A measurable offset need not be pathological

One research pupillometer study of 245 healthy participants reported mean pupil diameter 5.39 ± 1.04 mm at 0 lux, 4.70 ± 0.97 mm at 4 lux and 2.84 ± 0.50 mm at 250 lux. These are sample means and standard deviations, not diagnostic ranges, and the CA-800 lighting sequence is not established as equivalent to those conditions.

What this test cannot establish. Routine CA-800 pupillometry is not a substitute for a swinging-flashlight assessment of an afferent defect, a neuro-ophthalmic examination, or a validated neurological pupillometer. New anisocoria with ptosis, diplopia, severe headache or other neurological symptoms merits urgent assessment rather than interpretation from a printout alone.

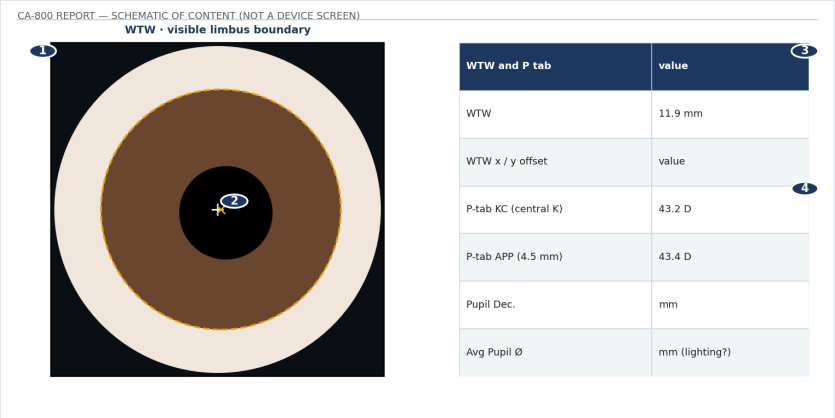
Sources: [1] §§13.7, 14.6, 17.5; [7]. Broad size ranges are orientation values, not instrument thresholds.

17 Corneal diameter and centration (WTW and P tab)

Figure 18 · WTW and the P tab

What the diameter and centration fields contain.

1. **Image** with the detected visible limbus; manual boundary edits update the result.
2. **Offset** of the limbus/iris centre from the fixation reference (WTW x/y).
3. **WTW value** in mm — the visible diameter, not the internal sulcus or angle-to-angle diameter.
4. **P tab**: KC here means central keratometry, not a keratoconus flag; APP over the 4.5 mm zone; pupil decentration and average pupil diameter under the actual lighting.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
WTW / corneal diameter, mm	Visible limbus-to-limbus corneal diameter inferred from the image	Many adult measurements fall around 11–12.5 mm. The device, visible limbus boundary, age and population affect the result
WTW x/y offset / decentration	Offset of the limbus/iris centre from the fixation reference. Manual changes to boundary markers update the result	No universal normal limit. It helps geometric planning but is not a direct sulcus-to-sulcus or angle-to-angle measurement
P-tab KC, D	Central keratometry in this particular pupil-related panel	This KC label means central corneal power; it does not mean a positive keratoconus diagnosis
P-tab APP, D	Average power over the defined 4.5 mm area	Compare with central corneal power and pattern. The 4.5 mm analytical diameter is not necessarily the measured pupil diameter
Pupil Dec., mm	Pupil offset from the instrument's stated reference	Interpret with the image and reference markers. Do not convert a linear distance to an angle without a valid geometric model
Avg Pupil Ø, mm	Mean pupil diameter associated with the acquisition	Use the actual lighting condition. A MAP image pupil is not automatically a fully dark-adapted PUP measurement

WTW helps contextualise the relationship between corneal size and a selected contact-lens diameter. Combined with topography, it supports initial geometric planning. It does not describe the full scleral shape or establish the final scleral-lens landing-zone fit. One healthy adult Saudi sample measured with Pentacam AXL Wave had WTW 11.95 ± 0.39 mm; that is population context, not a CA-800 reference interval. A visibly unusual diameter should be verified at the slit lamp or with a second method before attaching a congenital or acquired diagnosis.

> **Common error:** a manually drawn visible limbus is not the anatomical ciliary sulcus. WTW alone must not be treated as a direct measurement of the internal diameter used for implant sizing.

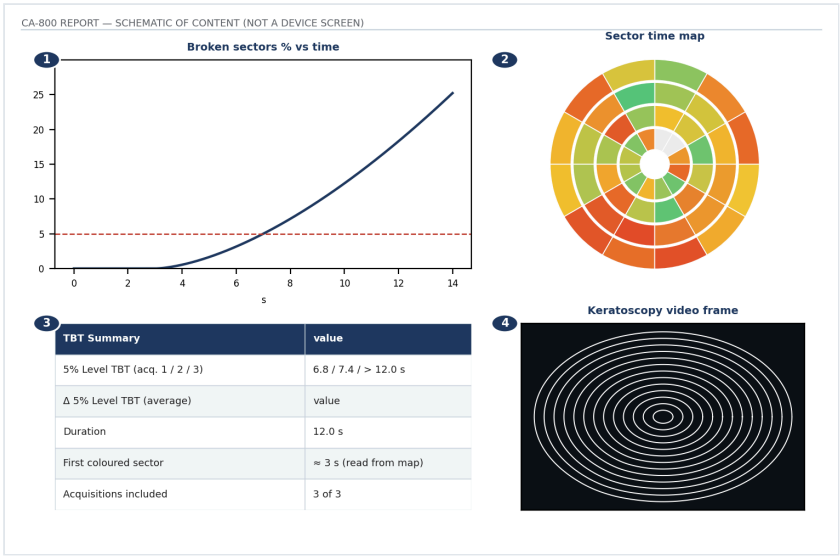
Sources: [1] §§14.1.5, 14.8; [8].

18 Tear breakup: the key distinction between first break and the 5% level

Figure 19 · The TBT Summary report

What the non-invasive breakup report contains.

1. **Broken-sector curve**: proportion of analysed sectors classified broken against time; the 5 % line marks the reported endpoint.
2. **Sector time map**: per-sector breakup time across included acquisitions; an uncoloured sector had no detected breakup.
3. **Summary table**: 5 % Level TBT per acquisition, Δ 5 % Level TBT (the average of included acquisitions), duration, and any "> Duration" censoring.
4. **Keratoscopy video** frame — use the raw video to distinguish tear change from lid intrusion, movement and focus loss.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

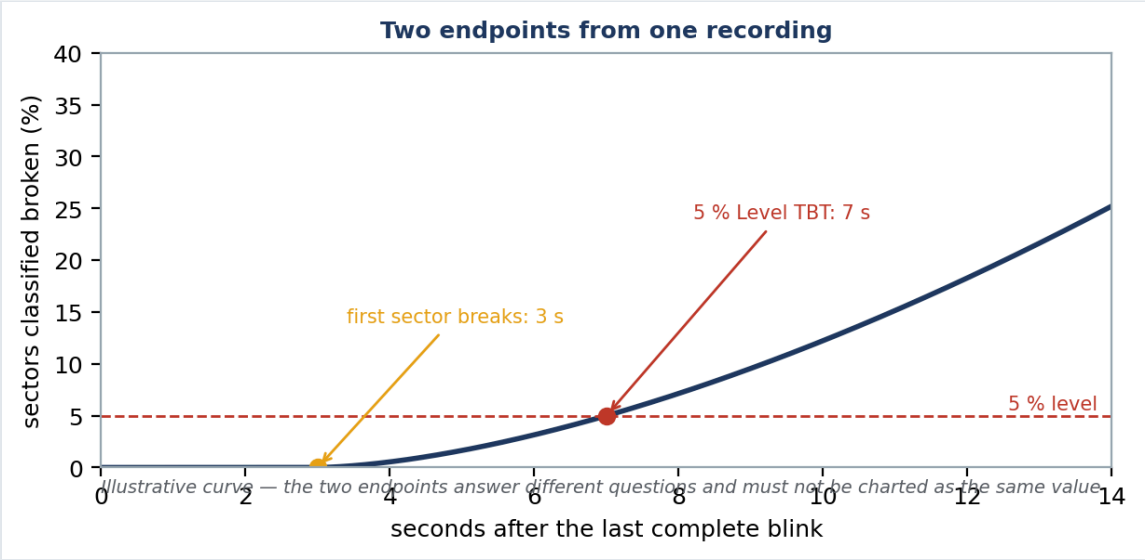


Figure 20 One recording, two endpoints: the first sector breaks at 3 s; the 5 % level is reached at 7 s. Illustrative curve.

Non-invasive breakup assessment observes changes in the reflected ring pattern after a blink. It evaluates surface stability without adding fluorescein. However, different instruments and software versions do not necessarily define "breakup time" in the same way, and this is the single most consequential definitional trap in the ocular-surface reports.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
First-break NIBUT	Time from the last complete blink to the first detected non-invasive tear breakup	TFOS DEWS III uses NIBUT <10 s as one sign of loss of homeostasis in its diagnostic pathway, together with a positive symptom screen
CA-800 5% Level TBT	In the reviewed software, time until 5% of analysed sectors are classified as broken	It need not equal the first-sector time. No validated universal CA-800 5%-endpoint normal/abnormal cutoff was identified
CA-800 Δ 5% Level TBT	Average of the 5%-endpoint times from included acquisitions	The Δ label is the software's summary notation here; it does not mean change from the previous visit
Sector average map	For each sector with detected breakup, an average breakup time across acquisitions	A spatial average is not the same as averaging all corneal sectors into a first-break time. Uncoloured sectors need image review

Consider an illustrative acquisition in which the first sector breaks at 3 s and the 5% level is reached at 7 s. Both numbers are correct; they answer different questions. The first-break time describes the earliest focal instability; the 5% time describes when a defined proportion of the analysed surface has become unstable. A report that prints only the 5% figure has not measured what a first-break instrument measures.

> **Applying the 10-second reference.** Document exactly which endpoint was measured. A 5% value below 10 s supports rapid instability if the acquisition is valid, but a 5% value above 10 s does not exclude an earlier focal breakup. Do not label it "normal NIBUT" solely from that threshold.

What TFOS DEWS III actually specifies

The 2025 TFOS DEWS III Diagnostic Methodology report recommends screening with the OSDI-6 questionnaire at a cut-off score of ≥4. A positive result together with **one** of the following gives a diagnosis of dry eye: a non-invasive breakup time <10 s; or tear-film hyperosmolarity (≥308 mOsm/L in either eye or an interocular difference >8 mOsm/L); or >5 corneal fluorescein and/or >9 conjunctival lissamine-green punctate spots and/or lid-margin lissamine-green staining of ≥2 mm length and ≥25% width. Note that these are the DEWS III criteria; the DEWS II (2017) symptom thresholds of OSDI ≥13 or DEQ-5 ≥6 have been superseded and should not be quoted as current.

The CA-800 can contribute the NIBUT sign to that pathway only if the endpoint it reports corresponds to the "non-invasive breakup time" the report intends. DEWS III does not, in the accessible abstract, specify a first-break versus proportional endpoint, and the 10 s threshold was developed largely from first-break measurements on other instruments. A CA-800 5% Level TBT below 10 s is therefore a supportive but not a formally equivalent sign. Record the endpoint alongside the value in every chart entry.

Other instruments define breakup differently

The OCULUS Keratograph 5M reports NIKBUT, and a clinical evaluation of the device describes it as measuring "the first time the tears break up anywhere on the cornea"; the same study found Keratograph NITBUT was shorter than a Tearscope measurement by 12.35 ± 7.45 s on average and that 63% of subjects had a NITBUT below 5 s. The Medmont E300 offers a tear-film analysis that captures an image sequence after a blink and analyses changes in surface quality. Each of these uses its own detection algorithm, sampling area, frame rate and endpoint. A patient measured on two of them will receive two different numbers for reasons that have nothing to do with the tear film.

What has been published about CA-800 breakup measurement

Three peer-reviewed observations frame the reliability of the CA-800 NIBUT output.

- In 141 soft contact-lens wearers measured **with the lenses in situ** — a pre-lens tear-film measurement, not the uncovered cornea — CA-800 NIBUT repeatability was 5.4 s with an intraclass correlation of 58.6% for the whole sample (4.2 s / 48.8% in asymptomatic and 7.1 s / 68.4% in symptomatic wearers), against 7.3 s /

32.7% for a subjective tearscope method. The CA-800 gave significantly shorter values than the subjective method (median 3.3 vs 8.1 s overall). The authors concluded that the objective method was more reliable but reported shorter times, and that symptomatic wearers may need more repeated measurements. A correction to this paper was published in 2025; its content could not be verified for this edition, and no numerical reliability threshold from it is adopted here. These figures describe pre-lens tear-film measurement during lens wear and should not be presented as repeatability limits for the uncovered cornea or for lens-off treatment monitoring.

- In 295 subjects, NIBUT measured with the CA-800 showed no significant correlation with OSDI ($r = –0.11$) or a visual-analogue discomfort score; only the severe-OSDI group showed a weak inverse correlation ($r = –0.22$).
- In 44 distance-learning students aged 15–25 **recruited for ocular-surface complaints** (redness, stinging, increased blinking; mean OSDI 37), mean CA-800 non-contact breakup time was 3.18 ± 2.0 s (range 1.24–8.80 s). This is a symptomatic sample and does not by itself show that the instrument produces short readings in healthy eyes.

The practical reading of these three results: in the one direct comparison, made through a contact lens, the CA-800 reported shorter times than a subjective method with repeatability of several seconds; in a symptomatic sample its readings were short; and a single value correlates poorly with symptoms. No study of CA-800 breakup repeatability on the uncovered cornea was identified. A short CA-800 breakup time is a finding to corroborate, not a diagnosis to record.

Sources: [1] §14.11; [4]; [15–16]; [22]; [23]; [24]; [40].

19 Tear breakup fields and dynamic maps

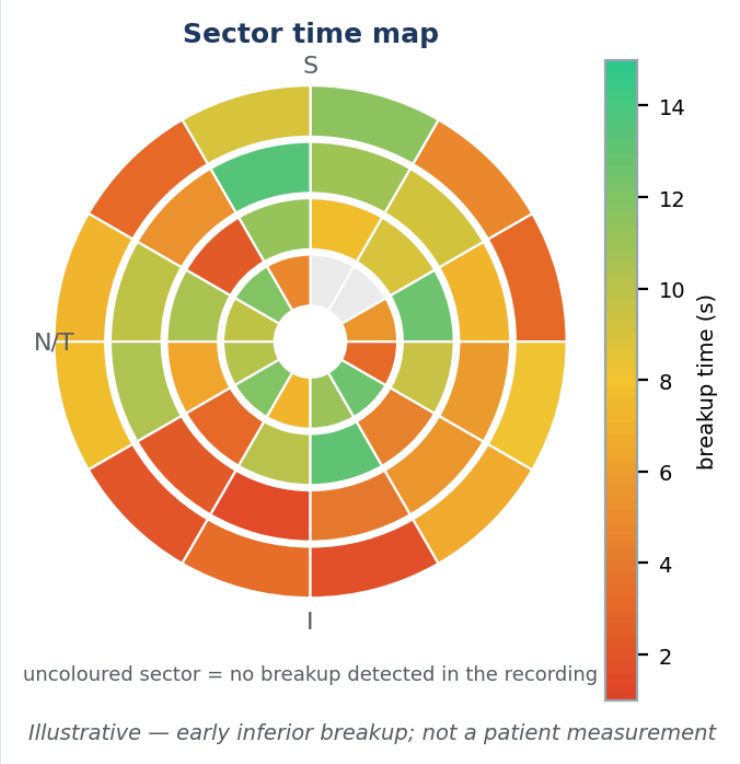


Figure 21 A sector time map with repeated early inferior breakup; uncoloured sectors had no breakup detected in the recording. Illustrative simulation.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
5% Level TBT, s	Time at which the broken-sector proportion first reaches 5% in one acquisition	Longer usually indicates more stable coverage under that protocol. Interpret against repeated results, symptoms and the actual movie
Duration, s	Length of the analysed interval. Rev. 18 permits acquisition up to 30 seconds	Short observation limits interpretation. Inability to hold the eye open is not the same as a measured breakup endpoint
> Duration	The 5% endpoint was not reached before recording ended	A lower bound, not an exact number. "> 20 s" must not be converted to exactly 20 s, zero, or a missing result
Broken sectors, %	Proportion classified as disrupted at a specified time; displayed as a time curve	Compare curves at matched elapsed times. There is no established universal normal curve or percent at every time point
Sector time map	Spatial timing: earlier breakup tends toward red, later toward green in the summary	Repeated early regions can explain focal surface vulnerability. An uncoloured sector means no detected breakup in the recorded data, not proven lifelong stability
Acquisition inclusion	Checked acquisitions contribute to the summary; unchecking changes averages and the report	Exclude only for a documented quality reason. Otherwise selection can bias the result toward apparent improvement
Keratoscopy / Break / Map video	Raw video, breakup overlay, or time-resolved axial/tangential topography	Use raw video to distinguish real tear change from lid intrusion, movement and focus loss

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Wavefront video / RMS, µm	Time-varying OPD, astigmatism, spherical aberration, coma or high-order residuals	Rising aberration after a blink can support tear-related visual fluctuation. No validated universal normal rate of rise is established

Practical acquisition caveats

The manual describes automatic restart if a second blink occurs within five seconds. Therefore, review the saved interval in a patient who blinks very early; an unrecorded or restarted attempt is not evidence that stability exceeded five seconds. Record lens-on versus lens-off conditions and do not pool those measurements.

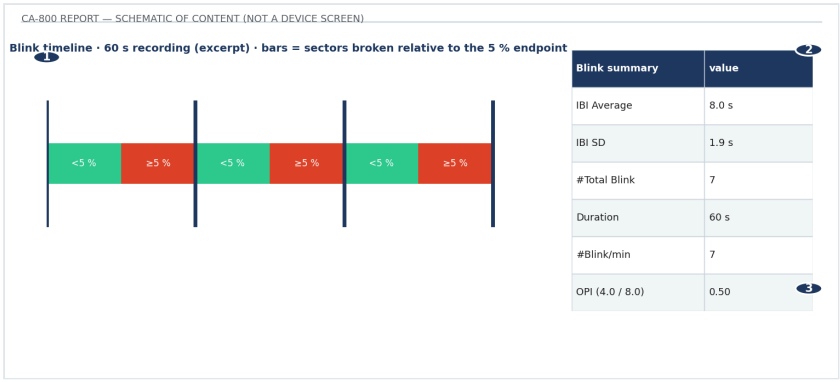
Sources: [1] §§13.9.4, 14.11; [15–16].

20 Blinking and ocular surface protection

Figure 22 · The Blink report

What the blink analysis contains.

1. **Timeline** of detected blinks over the analysed recording (manual maximum five minutes).
2. **Summary**: IBI average and SD, total blinks, duration, blinks per minute.
3. **OPI**: 5 % Level TBT divided by mean IBI; the bars mark whether fewer or more than 5 % of sectors are broken, and focal breakup can occur before that endpoint. Rev. 18 retains one blink acquisition for both eyes.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

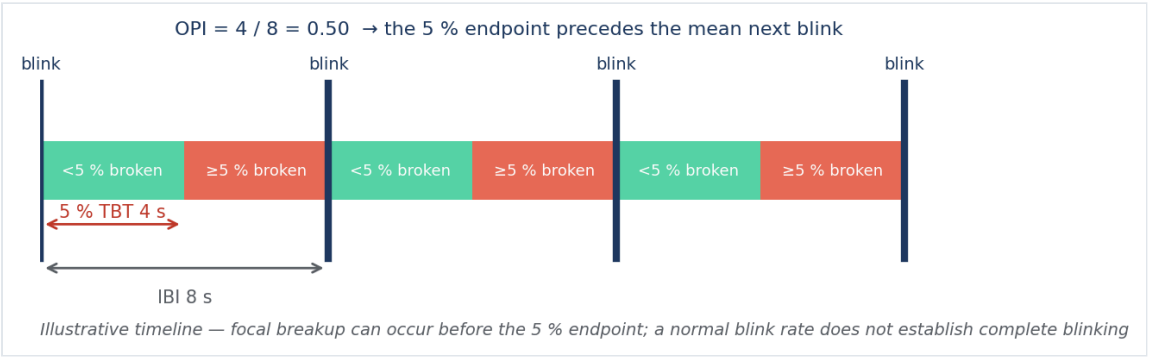


Figure 23 OPI worked example: 5 % TBT 4 s and IBI 8 s give OPI 0.50. Illustrative timeline.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
IBI Average, s	Mean interval between detected consecutive blinks. Used as the denominator of OPI	Shorter intervals replenish tears more often; long intervals may permit exposure. No fixed normal interval applies to every task
IBI SD, s	Variability of the intervals, not uncertainty of the mean	Large variation suggests irregular blinking or acquisition problems; inspect whether long pauses are hidden by the average
#Total Blink	Number of detected blinks during the analysed recording	No normal total independent of recording length. Verify automatic detection if the count seems inconsistent with observation
Duration, s	Total analysed blink recording time. Manual maximum is five minutes	Longer representative observation may capture behaviour better, but the task and instructions must remain comparable
#Blink/min	Blink count normalised to one minute	Quiet-awake rates are often roughly 10–20/min but vary substantially. Reading commonly lowers the rate; conversation can increase it. This is not a diagnostic interval
OPI, dimensionless	CA-800 5% Level TBT divided by mean IBI; the summary uses the average 5% TBT	<1: the 5% endpoint occurs before the mean next blink. ≥1: it occurs at/after that interval; this does not guarantee absence of earlier focal exposure

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Blink completeness	Clinical observation of whether the lids fully redistribute tears	The reviewed report does not specify an automatic incomplete-blink percentage. A normal rate does not establish complete blinking

Worked examples. TBT5% = 4 s and IBI = 8 s gives OPI = 0.50. TBT5% = 12 s and IBI = 4 s gives OPI = 3.0. These explain timing; they do not independently grade dry-eye severity. If the numerator is ">20 s" and IBI = 4 s, the derived OPI is ">5", not exactly 5.

The original OPI concept used breakup time relative to the interblink interval. The CA-800's 5% numerator can miss earlier focal loss of protection. Rev. 18 also retains only one blink acquisition for both eyes; the latest replaces the previous one. Thus eye-specific OPI values may share the same denominator.

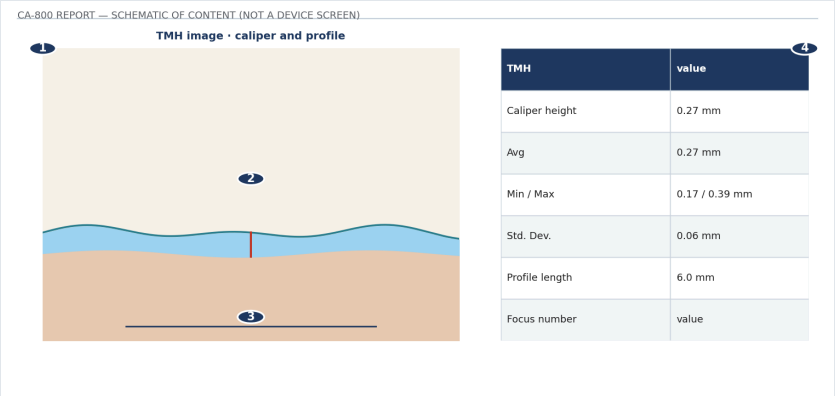
Sources: [1] §§13.9.3, 14.11; [10–11].

21 Tear meniscus height

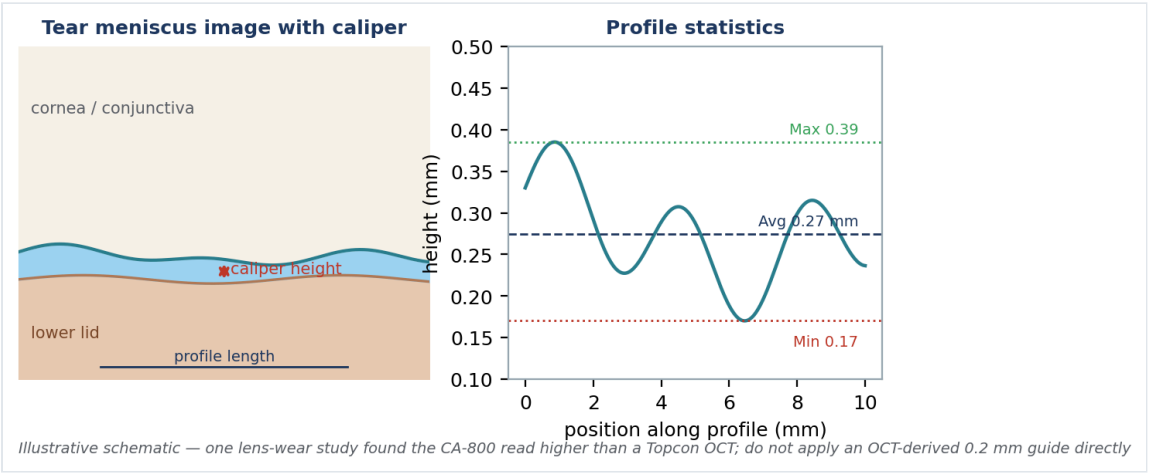
Figure 24 · The TMH report

What the meniscus report contains.

1. **Meniscus image** of the lower lid margin under the selected focus and enhancement.
2. **Caliper** between the selected lower and upper boundaries at one position.
3. **Profile length** and control points defining the analysed extent; changing the length changes the mean and extremes.
4. **Statistics**: caliper height, average, minimum, maximum, SD, focus number.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.



Illustrative schematic — one lens-wear study found the CA-800 read higher than a Topcon OCT; do not apply an OCT-derived 0.2 mm guide directly

Figure 25 Tear meniscus caliper and profile statistics. Illustrative schematic; in the one published comparison the CA-800 read higher than a Topcon OCT.

TMH estimates the height of the lower tear reservoir, providing context for aqueous tear volume. It is not a direct lacrimal secretion rate, a Schirmer measurement, or total tear volume. A normal reservoir can coexist with rapid evaporation or poor tear spreading.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Caliper height, mm	Distance between selected lower and upper boundaries of the meniscus at one image position	About 0.2–0.3 mm is a commonly used orientation value. <0.2 mm can suggest a reduced reservoir, but is not a universal CA-800 diagnostic boundary
Caliper position / angle	Location and orientation of the measurement across the meniscus	No healthy numerical target. Measure consistently and avoid oblique placement, lid tissue or reflection edges
Min / Max, mm	Smallest and largest height along the analysed profile	A local minimum can be low despite an adequate central value; extremes are sensitive to boundary errors and the selected profile length

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Avg, mm	Mean profile height across the selected region	Useful for repeated assessments with matching location and length. It is not identical to a single central caliper measurement
Std. Dev., mm	Variation of height along the profile	Greater variation can reflect an uneven meniscus, lid anatomy or tracing problems. No universal normal SD was verified
Profile length / control points	Extent of the analysed meniscus and manually anchored boundaries	Changing the sampled length changes the mean and extremes. Preserve comparable boundaries in follow-up
Focus number / enhancement	Acquisition focus indicator and contrast aid	The focus number is not tear quality. Enhancement helps visibility but does not create additional physical height information

Interpret low and high values in context

A repeatedly low meniscus with symptoms and corroborating findings supports investigation of aqueous deficiency. A high meniscus can reflect reflex tearing, recent drops, punctal occlusion or impaired drainage; it does not establish normal tear quality. Recent blinking and the time of photography influence the result.

Method matters. Published TMH measurements differ with viewing geometry and age; some otherwise healthy elderly eyes measure below 0.2 mm. In a study of 121 contact-lens wearers, CA-800 TMH repeatability was 0.07 mm with an intraclass correlation of 0.93, and in that contact-lens-wear study mean CA-800 TMH exceeded the Topcon 3D OCT-2000 measurement on the same eyes (0.22 ± 0.08 vs 0.17 ± 0.06 mm); the authors concluded the two methods might not be interchangeable. That is one comparison in one population against one OCT platform, not a universal bias. It is sufficient reason not to map a 0.2 mm orientation value derived from OCT literature directly onto a CA-800 caliper reading. Corroborate the finding rather than diagnosing aqueous deficiency from one image.

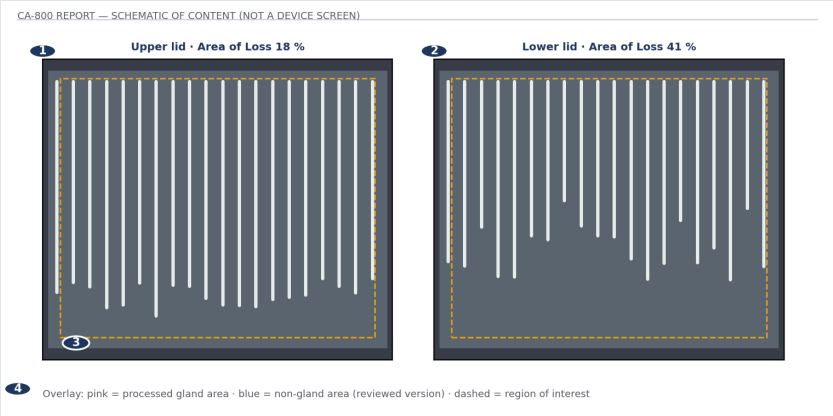
Sources: [1] §§13.9.2, 14.10; [9]; [21].

22 Meibography and gland loss

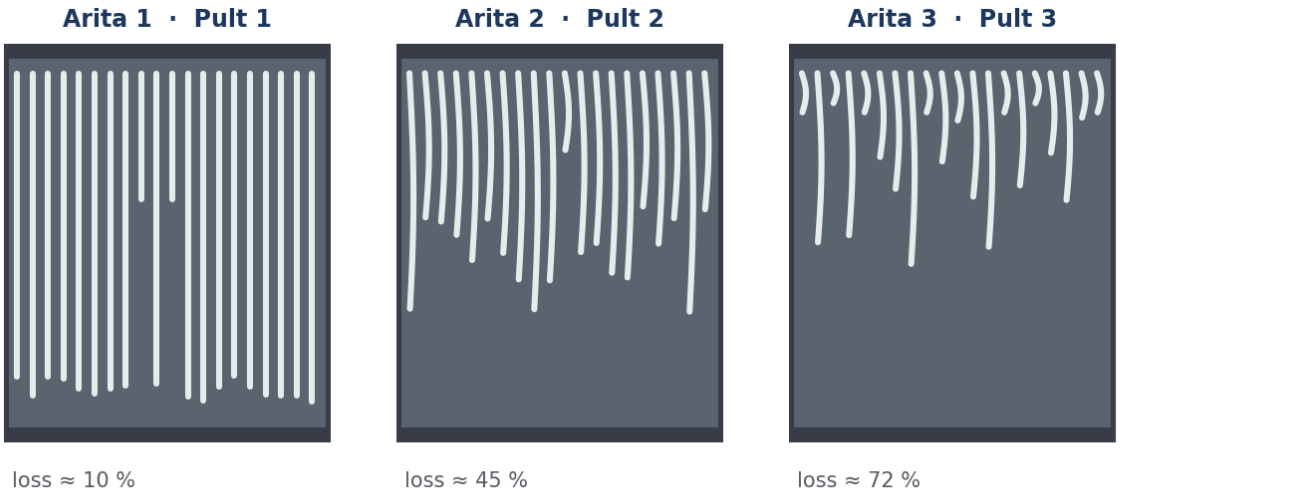
Figure 26 · The MEIB report

What the meibography report contains.

1. **Upper lid** infrared image with the computed area of loss for the selected region.
2. **Lower lid**, recorded separately; incomplete eversion creates false apparent loss.
3. **Region of interest** drawn manually; include comparable tarsal tissue each time.
4. **Overlay**: in the reviewed version blue is area not covered by glands and pink is processed gland area. Colour is segmentation output, not proof of destruction.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.



Illustrative infrared gland schematics — grade only with the scale named; the CA-800 reports an area-of-loss percentage, not a grade

Figure 27 Schematic meibography at three loss levels with the Arita meiboscore and Pult five-grade scale. Grade only with the scale named; the CA-800 reports a percentage, not a grade. Illustrative.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Upper / lower lid	Infrared view of the everted tarsal plate and visible glands	Record each eyelid separately. Incomplete eversion can create false apparent loss
Area of Loss, %	Area without detected glands divided by the selected total region, multiplied by 100	Lower loss generally indicates greater visible preservation. A single universal age-independent normal percentage is not established
Region of interest	Area manually selected for software analysis	Include comparable tarsal tissue each time; avoid counting hidden lid regions, reflections or non-gland tissue

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Blue / pink overlay	In the reviewed version, blue is area not covered by glands; pink is processed area covered by glands	Inspect agreement with the raw image. Colour is segmentation output, not direct proof of permanent gland destruction
Morphology	Shortening, distortion, dilation, tortuosity and dropout, described by the clinician	No universal normal value for every shape. Visible structural loss supports MGD assessment but does not quantify secretory function
Enhancement	Contrast processing to improve visibility	Use a consistent processing setting across visits. Altered visibility can change apparent area loss without true anatomical change

Optional clinical grading: label the scale explicitly

Two grading conventions are widely used in the literature, and a CA-800 percentage maps onto neither automatically.

Scale	Grades	Interpretation
Arita meiboscore (2008), per lid	0 no loss; 1 lost area less than one third; 2 one third to two thirds; 3 more than two thirds. Summed per eye 0–6	Developed on 236 volunteers aged 4–98 with a non-contact infrared meibograph; score correlated with age (R = 0.428). A clinical grading convention, not a CA-800 output
Pult five-grade scale (2013), per lid	0 no gland loss; 1 <25%; 2 26–50%; 3 51–75%; 4 >75%	The pictorial scale the Keratograph documentation refers to as the JENVIS grading scales; intra-observer agreement was better with computerised grading than with either subjective scale

Grade 0 on either scale is the best-preserved category, not a requirement that every healthy adult shows absolutely zero loss. Do not replace the CA-800 percentage with an unlabelled grade, and do not pool upper and lower values without naming the method. Assess gland expressibility and secretion quality separately; those are not measured by the infrared image.

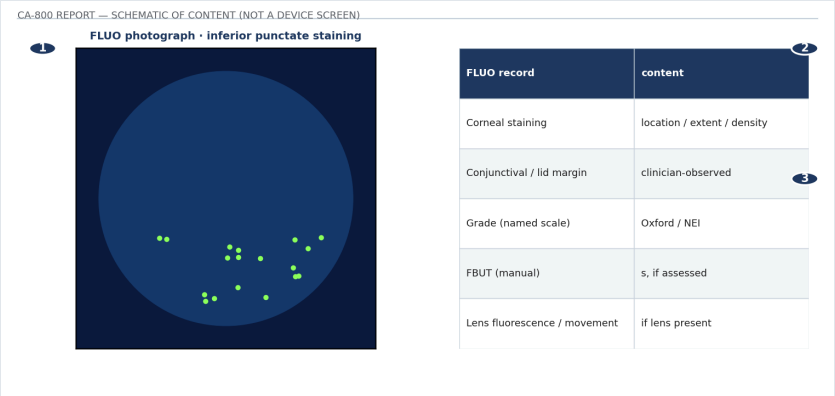
Sources: [1] §14.9; [17]; [34]; [47].

23 Fluorescein imaging and staining

Figure 28 · The FLUO report

What the fluorescein record contains.

1. **Photograph or video frame** under blue illumination; the report documents imaging, not an automatic staining assay.
2. **Record fields**: staining location, extent, density and pattern; conjunctival and lid-margin observations; a named grading scale.
3. **Manual FBUT** if assessed, and lens fluorescence and movement when a lens is present. This is not the non-invasive 5 % calculation.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

The FLUO report documents surface fluorescence and, when a lens is present, the observed fluorescein pattern and lens movement. The reviewed manual describes imaging rather than an automatic tear-production, staining-severity or permeability assay.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Corneal staining	Location, extent, density, confluence and pattern of epithelial staining	Expected: absent or minimal staining in a healthy surface. Focal, confluent or persistent defects require cause-specific evaluation
Conjunctival / lid margin staining	Clinician-observed surface staining, with the dye and illumination stated	Fluorescein alone does not replace lissamine-green assessment. A photograph should not be assigned a score for tissue or dye it did not capture
Staining grade	A separately applied standardised scale, such as Oxford or NEI	Low/zero is favourable, but scales are not interchangeable. State the scheme, region, dye dose and observation time
FBUT / TBUT, s	If manually assessed, time from a blink to visible tear-film breakup after fluorescein	Historically a value <10 s was used as an instability clue. The TFOS DEWS III diagnostic summary pairs its NIBUT <10 s sign with a fluorescein breakup-time criterion at 5 s; confirm the exact wording in the full report before applying it. Volume and technique strongly affect the result. This is not the CA-800 non-invasive 5% calculation
Pooling / negative staining	Fluorescence collecting in depressions or reduced fluorescence over elevated/unwetted areas	Pooling is not necessarily epithelial damage. Negative staining can reveal an irregular surface and must be interpreted with slit-lamp findings
Lens fluorescence	Observed tear distribution beneath/around a lens and its wetting	An adequate pattern depends on lens design. A green zone does not have one universal safe clearance thickness
Lens movement / centration	Position and motion in the real-time recording	Assess during blinking and settling. It is observed on-eye behaviour, distinct from the Lenses module's geometric simulation

What gives this report clinical meaning?

Document where the staining occurs and the associated examination. Inferior exposure, diffuse punctate staining, a focal abrasion and contact-lens bearing can have different causes despite similar total stain scores. Severe pain, photophobia, an infiltrate or a persistent epithelial defect warrants prompt clinical assessment rather than interpretation as routine dry eye.

Sequence: acquire non-invasive tear and corneal measurements before instilling dye. Use the same staining method at follow-up so changes are interpretable. Note that the DEWS III staining criteria count punctate spots (>5 corneal, >9 conjunctival) rather than applying a named grading scale, and lid-margin staining is specified by length and width; a photograph graded on the Oxford scale cannot be converted to those counts after the fact.

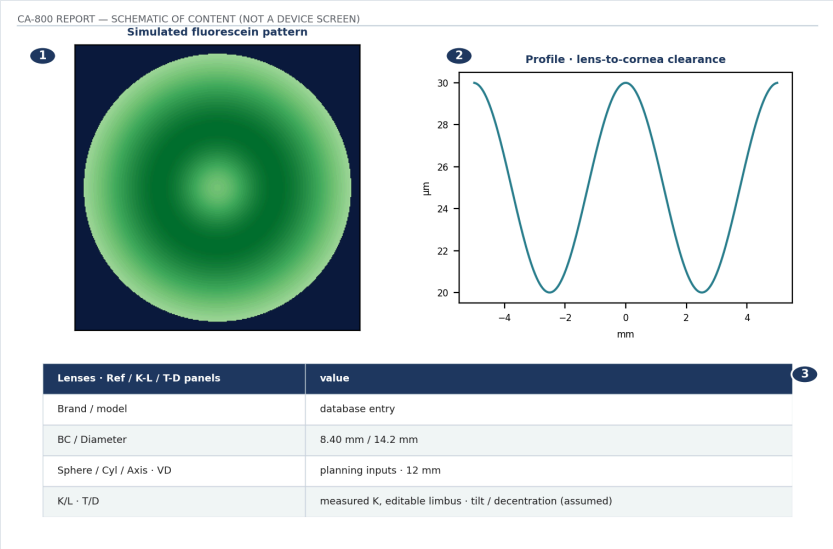
Sources: [1] §§13.8, 14.7; [4]; [18].

24 Contact lens fitting simulation

Figure 29 · The Lenses module

What the fitting simulation contains.

1. **Simulated fluorescein pattern** for the selected design on the reconstructed cornea — geometry, not observed on-eye behaviour.
2. **Profile** of assumed lens-to-cornea distance along a chosen meridian; no universal clearance target.
3. **Ref, K/L and T/D panels**: refractive inputs and vertex distance; measured K and editable limbus; user-set tilt and decentration.



Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

The Lenses module compares the reconstructed cornea with a selected lens design from its database. It can reduce the number of trial lenses, but it does not directly measure the fit of that lens on the living eye. The manufacturer explicitly distinguishes simulated geometry from actual wear.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Brand / model	Selected lens design and manufacturer data	No normal value. Confirm the exact design and database version; models with the same base curve can have different geometry
Base curve / BC, mm or D	Radius or curvature of the lens's central posterior region	Patient- and design-specific. A smaller mm value is steeper. Central K alone cannot determine the final fit of a complex lens
Diameter, mm	Overall selected lens diameter	Depends on corneal size, lens purpose and design. It is not interchangeable with back optic zone diameter
Sphere / cylinder / axis	Refractive inputs or lens parameters in the Ref panel	These are entered or calculated planning values, not a CA-800 manifest refraction. Verify cylinder notation
VD, mm	Vertex distance used for refractive conversion	Use the measured clinical distance appropriate to the input refraction. It is not corneal clearance
K/L	Keratometric data and corneal diameter; limbus can be edited	Check measured geometry before relying on the proposed lens. Review the boundary if diameter appears implausible
T/D: tilt / decentration	User-adjustable simulated orientation and lens position	An assumed position, not observed on-eye centration. Changing it changes the predicted fluorescein pattern
Apical clearance / Profile	Assumed apical separation and a graph of lens-to-cornea distance along a chosen meridian	No universal target for all lens designs. Simulation does not measure settled scleral vault, tear exchange, bearing pressure or oxygen delivery

Turn simulation into a fitting decision

Document the selected design and all modified assumptions. Then assess the physical trial lens, centration, movement, fluorescein distribution, comfort, over-refraction and tissue response. For scleral designs, assess central/limbal clearance and the landing zone with appropriate clinical methods; Placido coverage does not constitute complete corneoscleral profilometry.

Sources: [1] §§16.1, 17.7.

25 Toric IOL module: biometry and preoperative inputs

Figure 30 · The toric IOL module

Which fields are measured by the CA-800 and which are entered.

1. **Measured**: K1 / K2 populated from the CA-800 Data function.
2. **Entered**: axial length, ACD and measurement modality, SIA, incision location, SEQ. Their presence in the report does not mean the CA-800 measured them.
3. **Outputs**: spherical and cylinder power, IOL axis, predicted residual astigmatism.
4. **Summaries** of corneal data reliability and of every entered value — verify against the originating reports and the intended eye.

Schematic of the report's documented content drawn from the manual's field list; values are illustrative and the layout is not a reproduction of the device screen.

Measured versus entered. The CA-800 can supply anterior corneal K values. Axial length and anterior chamber depth in this module are external measurements entered by the operator; their presence in the report does not mean the CA-800 measured them.

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
AL, mm	Axial length measured by a separate biometer; major input to IOL power estimation	Many adult eyes are around 23–24 mm, with wide physiological and refractive variation. This is context, not an exclusion criterion
ACD, mm	Anterior chamber depth from the external measurement method	Often around 3 mm in adults; definition may start at epithelium or endothelium. Match the definition expected by the formula and input field
Optical / acoustical	Method used to acquire external biometric data	Choose the actual modality. Method or transcription errors can change the calculation
K1 / K2 and cylinder	Keratometric inputs; the CA-800 Data function can populate measured K	Require reproducible measurements and a stable surface. Preserve axis convention and distinguish anterior-derived K from total corneal astigmatism
SIA, D; axis context	Surgically induced astigmatism assumption	Surgeon-, incision- and method-specific. There is no single normal number to enter for all surgeons
IL, degrees	Planned incision location	A surgical input, not a measured ocular abnormality. Must correspond to the surgeon's intended meridian
SEQ, D	Spherical-equivalent field in the preoperative planning panel	The manual lists the field without fully defining its target semantics; confirm the installed workflow before treating it as target refraction or entering manifest SE
Formula / lens model	Rev. 18 lists Haigis, Hoffer Q, SRK II, SRK/T and Holladay I, plus a selectable toric lens database	No normal formula or implant. Validate available lens constants, model and formula with the surgeon's current planning workflow

Population biometric values explain what a number represents; they do not justify replacing a missing patient-specific measurement. Do not insert an "average" AL, ACD, SIA or target into a surgical calculation.

Calculation outputs and limitations

Parameter / unit	What it means and why it is used	Expected value / clinical interpretation
Spherical power, D	Calculated IOL spherical power for the chosen model and input set	No normal range or universal target. It depends on the eye, intended refraction, constants and formula
Cylinder power, D	Proposed toric component for the selected implant	Check whether values refer to the IOL plane or an equivalent corneal plane. They are not directly interchangeable
IOL axis, degrees	Proposed alignment orientation from the planning calculation	Must be interpreted with the chosen implant and surgical reference system; it is not automatically the corneal steep-axis label
Residual astigmatism, D; axis if displayed	Predicted cylinder remaining with the chosen implant and alignment	A small residual may be desired, but this is a prediction, not a guarantee of postoperative refraction or visual quality
Summary of corneal data	Astigmatism, irregularity, asymmetry, keratometry and keratoconus panels	These identify whether anterior corneal data appear reliable and regular enough to inform planning; they do not establish overall surgical suitability
Entered-data summary	AL, ACD, measurement modality and surgical assumptions carried into the calculation	Independently verify these against the originating reports and intended eye before clinical use

Posterior cornea matters. Anterior-only astigmatism does not necessarily equal total corneal astigmatism. Posterior curvature can change the magnitude and orientation relevant to toric correction. The reviewed CA-800 manual does not establish direct measurement of posterior corneal curvature, nor verify a contemporary posterior-corneal correction for every installed toric calculation. Confirm the actual implementation with the surgeon and manufacturer.

Use a surgical workflow, not a standalone printout. The operating surgeon should reconcile the calculation with current biometry, posterior-corneal treatment, ocular-surface stability, lens constants and surgical planning. Prior corneal refractive surgery, ectasia and markedly irregular corneas require special attention because standard anterior K assumptions may fail.

> **Clinical significance.** The report is decision support based on explicit inputs and assumptions. A precise-looking output can be wrong when the input K, eye, axis, biometric definition or lens model is wrong.

Sources: [1] §16.2; [5] for adult biometry context; [19].

26 When the CA-800 is not enough: what other instruments measure

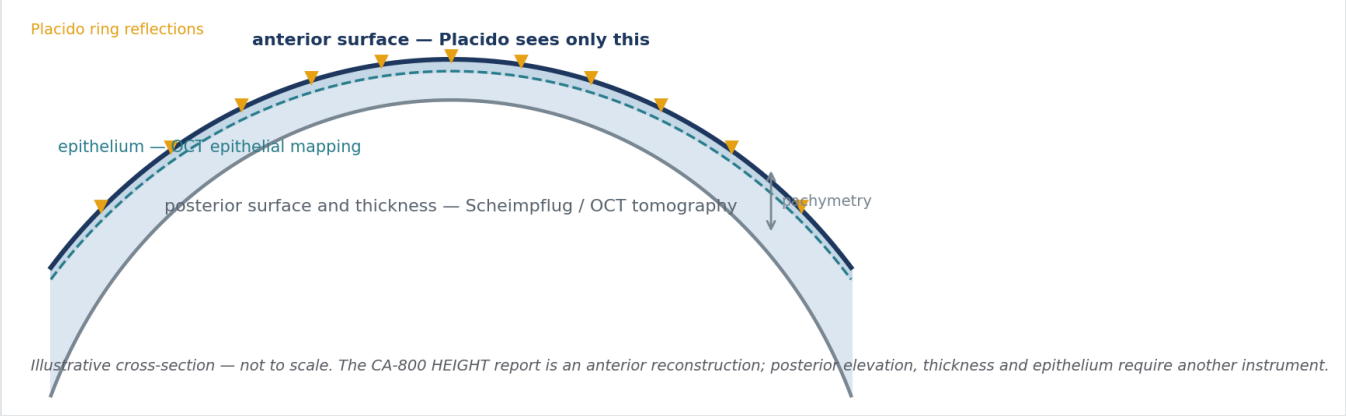


Figure 31 What each instrument class observes: Placido reflection reconstructs the anterior surface only; Scheimpflug tomography adds the posterior surface and pachymetry; anterior-segment OCT with Placido adds epithelial thickness. Illustrative cross-section, not to scale.

The CA-800 is a Placido reflection topographer with ocular-surface and pupil modules. The clinical questions it cannot answer on its own — posterior corneal shape, thickness distribution, epithelial thickness, corneal biomechanics — are exactly the ones other instrument classes were built for. This section describes what each class measures so that the reader knows which examination to request next, and why a number from one of them cannot be pasted into a CA-800 context.

Instrument classes

Class	Principle	What it measures that the CA-800 does not	Representative instruments (manufacturer-stated features)
Placido topography	Reflection of illuminated rings from the tear-coated anterior surface	Nothing additional; same class as the CA-800, with different ring counts, coverage and algorithms	CA-800: 24 rings, 6,200 measured points, coverage to 9.8 mm. Keratograph 5M: 22 rings, 22,000 evaluated points. ATLAS 500: 24 rings, 6,144 points, 9.3 mm coverage. Medmont E300: 32 rings, 9,600 points, coverage 0.25–11 mm
Scheimpflug tomography	Rotating slit camera images optical sections of the cornea rather than reflections from the tear film; this does not make it immune to surface-related measurement error	Posterior surface, pachymetry map, elevation of both surfaces, anterior chamber	Pentacam: rotating Scheimpflug, 50 images in two seconds
Scheimpflug plus Placido hybrid	Combines both principles in one capture	Both surfaces plus Placido anterior detail	Sirius: 25 Scheimpflug meridians plus one Placido image; anterior surface 35,632 points, posterior 30,000 points, 12 mm diameter. TMS-5: Placido (25 or 31 rings, up to 6,400 or 7,300 points) plus Scheimpflug slit-scan. Galilei G6: dual Scheimpflug plus Placido, aligned to the first Purkinje reflex
Anterior-segment OCT plus Placido	Optical coherence tomography cross-sections plus Placido reflection	Both surfaces, pachymetry, and **epithelial thickness** mapping; 16 mm section width	MS-39: SD-OCT with Placido; axial resolution of approximately 3–5 µm reported in the literature; pupil and tear-film analysis

Class	Principle	What it measures that the CA-800 does not	Representative instruments (manufacturer-stated features)
Very-high-frequency ultrasound	Acoustic sectioning	Epithelial and stromal thickness independent of optical clarity	Artemis (research and specialist use)

Sources: [20]; [25]; [37]; [39]; [40]; [41]; [42]; [43]; [44]; [45].

Same words, different meanings: an index-by-index comparison

Index	Instrument and origin	What it is	Threshold as published, and where it applies
KPI (CA-800)	CA-800 KC/AK tab	Keratoconus probability index combined with AK, AGC and SI, shown as a green/yellow/red class	Numerical class boundaries are not documented in the reviewed manual. Use the class the software displays
KPI (Klyce/Maeda)	Tomey TMS series, 1994	A linear discriminant function of eight TMS indices (Sim K1, Sim K2, UPS, DSI, OSI, CSI, IAI, AA) developed on TMS-1 data; validation sensitivity 89%, specificity 99%	A value above 0.23 is described in the secondary literature as suggestive of keratoconus, on the TMS. Not a CA-800 value despite the shared abbreviation
KISA%	Rabinowitz and Rasheed, 1999; videokeratography	Product of four terms × 100 / 300: an adjusted K (central K below 47.2 D is replaced by 1, above 47.2 D by K – 47.2), the I–S value, the astigmatism term and the skewed radial axis term, each taken as an absolute value with any component below 1 set to 1	At a cutoff of 100, 280 of 281 participants were correctly classified; a range of 60–100 was proposed for suspects. Developed on a specific videokeratoscope and its I-S sampling; not implemented on the CA-800
I-S value	Rabinowitz and McDonnell, 1989	Difference between average inferior and superior power at defined points 3 mm from centre	The commonly quoted 1.4 D threshold is attributed to that work in secondary sources; its exact primary wording was not verified for this edition. The CA-800 SI uses its own sampling regions and is not the same calculation
Central K >47 D	Rabinowitz-era videokeratography criteria	A single-value flag for steep central cornea	A population heuristic from a different device. Ordinary central K on a CA-800 neither confirms nor excludes ectasia
SRI / SAI	TMS series	SRI: power-gradient differences across 256 semi-meridians; SAI: power differences between points 180° apart across 128 meridians	SRI below about 0.56 described as normal, on the TMS. The CA-800 SAI is a different 4.5 mm asymmetry statistic in dioptres
PathFinder II	ZEISS ATLAS 9000	Software analysing 12 anterior corneal parameters against a clinical database, classifying normal, abnormal or pathological, with keratoconus, suspect and pellucid patterns	ATLAS-specific classification; the 12 parameters were not verifiable from manufacturer documentation for this edition

Index	Instrument and origin	What it is	Threshold as published, and where it applies
BAD-D	OCULUS Pentacam, Belin/Ambrósio Enhanced Ectasia Display	Regression-derived combined deviation from normal using anterior and **posterior** elevation, thickness progression and other tomographic parameters, expressed in standard deviations	Manufacturer guide: white <1.6 SD within normal limits, yellow ≥1.6 suspicious, red ≥2.6 abnormal. Published algorithm analyses report empirically optimal cutoffs of roughly 1.8–1.9 for BAD-D v3 and v4 in distinguishing normal from clinical ectasia. Requires posterior data the CA-800 does not have
Belin/Ambrósio elevation-difference limits	Pentacam	Change in elevation between the standard best-fit-sphere map (8.0 mm) and the enhanced-reference map that excludes the thinnest zone	Manufacturer guide: anterior <5 / 5–7 / >7 µm; posterior <12 / 12–16 / >16 µm (green / yellow / red). A difference between two Pentacam reference surfaces, not raw elevation; no CA-800 equivalent exists
ABCD staging	Belin and Duncan, 2016; Pentacam display	A: anterior radius over the 3 mm zone centred on the thinnest point; B: posterior radius over the same zone; C: thinnest pachymetry; D: distance corrected visual acuity	Normative data from 672 eyes (ARC 7.65 ± 0.236 mm, PRC 6.26 ± 0.214 mm, thinnest pachymetry 534.2 ± 30.36 µm). Three of the four components need tomography
Kmax	Pentacam and others	Location of maximum sagittal (axial) power on the front surface	A reading of the axial map's steepest point. The CA-800 AK is apical curvature, which is not automatically the same point or value
NIKBUT first / average	Keratograph 5M	First-break time anywhere on the cornea, and an average across the analysed area	Not the CA-800 5% Level TBT. See the tear breakup section
Meibo-Scan / JENVIS grading	Keratograph 5M	Infrared meibography graded on a pictorial five-grade scale	A grading convention applied by the clinician; not the CA-800 area-of-loss percentage

The pattern across every row is the same. Each index is a function of a particular instrument's sampling geometry, reconstruction algorithm and development dataset. The abbreviation is portable; the threshold is not.

Sources: [1] §14.1.4; [25]; [26]; [27]; [28]; [29]; [30]; [31]; [39]; [46]; [48].

Epithelial thickness mapping: the layer the CA-800 cannot see

Very-high-frequency ultrasound work described an epithelial "doughnut" pattern in keratoconus — localised central thinning surrounded by an annulus of thick epithelium — and proposed it as an aid to early diagnosis. The first Fourier-domain OCT epithelial mapping study reported normal central, superior and inferior epithelial thickness of 52.3 ± 3.6, 49.6 ± 3.5 and 51.2 ± 3.4 µm respectively, with a pattern-standard-deviation cutoff of 0.057 giving complete separation of normal from keratoconic eyes in that sample, and zonal repeatability of 0.7–1.9 µm. Subsequent work comparing three OCT platforms found epithelial thickness readings were not interchangeable between devices, with one platform reading thicker than another by about 4 µm. The relevance for the CA-800 reader is twofold: epithelial remodelling can mask or mimic an anterior-surface finding on Placido, and a Placido-suspicious cornea with a normal epithelial map on OCT is a different clinical proposition from one with a doughnut pattern.

Sources: [36]; [37]; plus the VHF ultrasound literature cited in [37]'s bibliography.

27 Six worked clinical examples

These are invented teaching examples. They demonstrate reasoning, not device-validated thresholds, diagnoses or treatment recommendations. Each follows the same four-question sequence: is the acquisition valid; what does the parameter actually describe; is the comparison like-for-like; what other examination would confirm or challenge the explanation?

1. Ordinary central power with regular astigmatism

Findings: Kflat 42.50 D, Ksteep 44.00 D; symmetric bow tie; repeatable axis; low irregularity and green KC classification. **Interpretation:** 1.50 D of regular anterior corneal astigmatism with no suspicious pattern on these scans. **Next question:** Does manifest refraction and acuity explain the complaint? If surgery is contemplated, a green topography alone does not replace the rest of the preoperative assessment.

2. Rapid breakup despite an adequate tear reservoir

Findings: TBT5% 4.0 s, mean IBI 8.0 s, OPI 0.50; TMH 0.27 mm; visible gland loss and reduced gland expressibility on separate examination. **Interpretation:** The tear surface becomes unstable before the average next blink, despite a reasonably sized reservoir. **Next question:** Evaluate evaporative contributors, blink completeness, inflammation and symptoms; TMH alone cannot exclude dry eye or identify its mechanism.

3. Suspected ectasia with confounding surface disease

Findings: Inferotemporal steepening, increased coma and yellow KC class on a poor tear surface. **Interpretation:** Ectasia is a possibility, but the poor surface can alter shape indices. **Next step:** Obtain reproducible quality measurements, review contact-lens history and add tomography and pachymetry when appropriate. If the pattern persists, do not dismiss it because central K falls within an ordinary range.

4. Apparent improvement that is not a valid comparison

Findings: HOA RMS is lower at follow-up, but baseline was analysed at 6 mm and follow-up at 3 mm. Meibography loss also appears lower, with a smaller selected region. **Interpretation:** Neither observation establishes anatomical or optical recovery. **Next step:** Reanalyse with matched apertures, coverage and gland regions, and examine concordance with symptoms and independently measured vision.

5. Two instruments, two breakup times, one patient

Findings: A referral letter reports NIKBUT "first" of 5.8 s on a Keratograph 5M. The CA-800 today shows 5% Level TBT 9.5 s, Δ 5% Level TBT 10.2 s across three acquisitions, with the earliest coloured sectors on the sector map at roughly 4 s. **Interpretation:** The two instruments have not disagreed. The Keratograph number is a first-break endpoint; the CA-800 summary is a proportional endpoint. The sector map shows evidence of early focal instability, but a sector value on a summary map may be an average across acquisitions and is not a validated first-break measurement. **Next step:** Record both values with their endpoints named. Do not chart "NIBUT improved from 5.8 to 10.2 s". If the DEWS III NIBUT sign is being assessed, the Keratograph first-break value meets it on that instrument; the CA-800 result should be described as supportive evidence of early breakup unless the acquisition, endpoint and method are confirmed.

6. Green class, family history, and a refractive-surgery request

Findings: A 24-year-old with a sibling treated for keratoconus requests laser refractive surgery. CA-800: green KC class, KPI low, SI near zero, regular bow tie, cylinder 1.25 D, Q –0.28 at 8 mm, good repeatability across three captures. **Interpretation:** The anterior surface is regular on this instrument today. That statement is accurate and it is not the answer to the question being asked, because the CA-800 has no posterior-surface, thickness-distribution or epithelial data, and the consensus literature places weight on precisely those for subclinical disease. **Next step:**

Tomography with posterior elevation and pachymetric progression, and epithelial mapping where available, before any surgical decision. Document that the Placido screen was unremarkable and that it was not the basis for clearance.

> **Reasoning sequence:** Is the acquisition valid? What structure or function does the parameter actually describe? Is the comparison like-for-like? What other examination would confirm or challenge the proposed explanation?

Sources: teaching synthesis from [1], [4], [12–19], [24], [25], [32].

28 A reproducible practitioner workflow

What to record in the chart

Record	Minimum useful content
Context	Eye; indication; software/hardware; prior surgery; lens type and time since removal; recent drops; testing conditions
Quality	Calibration status; acceptable repeats; ring coverage; fixation; surface artefacts; exclusions and manual edits
Corneal shape	Map type/scale; Kflat/Ksteep and axes; cylinder; sampling zones; irregularity/asymmetry; KC/CLMI class and notable values
Optical / pupil data	Wavefront aperture and term set; dominant aberration; pupil lighting protocol, diameter and reference for decentration
Ocular surface	Exact TBT endpoint; individual values and summary; duration/censoring; IBI/OPI; TMH sampling; gland loss by eyelid and region; staining method
Clinical interpretation	Pattern, concordance with symptoms/acuity/examination, alternatives, limitations and next evaluation or follow-up interval

Suggested narrative template

> "CA-800 examination of [eye], [software version], obtained for [indication]. Quality [adequate/limited] because [reason]; [number] acceptable repeats. [Axial/tangential] maps at [scale/zone] show [pattern]. Kflat [ ] D at [ ]°, Ksteep [ ] D at [ ]°; cylinder [ ] D. KC classification [ ]; relevant indices [ ]. TBT endpoint [5% level / first sector] with results [ ] s and duration [ ]; IBI [ ] s, OPI [ ]. TMH [method/value], MEIB [lid/ROI/loss], FLUO [dye/scale/pattern]. Compared with [date] using matched settings, [change/no clear change]. Clinical correlation: [ ]. Plan: [ ]."

Assessing treatment response

Define the endpoint before reviewing the follow-up. Repeat under comparable conditions and report both the numerical change and relevant patient function. A before/after improvement is an observation; demonstrating that a particular treatment caused it requires an appropriate study design and control of confounders. Small changes in gland segmentation, TBT or one topographic point need repeatability context — for CA-800 NIBUT measured through a soft lens, published repeatability was on the order of 4–7 s, which is larger than many "improvements" reported in practice; no lens-off repeatability figure has been published.

Sources: [1]; [4]; [10]; [13–18]; [22].

29 Desk reference: normal values, the practical summary

Parameter	Reference / expected direction	Essential qualification
Central K	Often about 43–44 D; broad orientation roughly 40–46 D	Population context only. No single K value establishes or excludes ectasia
Regular corneal cylinder	0 D means no principal-meridian difference; non-zero regular cylinder is common	No universal disease cutoff. Pattern, stability and visual consequence matter
Anterior Q	Often approximately –0.2 to –0.3 centrally	Diameter-, population- and instrument-dependent. Not a universal 8 mm CA-800 interval
WTW	Many adult eyes around 11–12.5 mm	Visible diameter only; not internal sulcus diameter
Pupil size	Photopic ~2–4 mm; mesopic ~3–6 mm; scotopic ~4–8 mm	Broad overlapping orientation ranges; age, lighting and medication matter
First-break NIBUT	<10 s is a TFOS DEWS III diagnostic sign with a positive OSDI-6 (≥4)	A sign, not an independent diagnosis. Do not substitute CA-800 5% TBT for this endpoint
CA-800 5% TBT	No universal validated numerical normal boundary identified	Longer tends to reflect greater stability; record raw movie, repeats and observation duration. Published repeatability ~4–7 s, measured through a soft lens; no lens-off figure
OPI	<1 means the chosen TBT endpoint precedes mean IBI	≥1 does not exclude focal early breakup, especially with a 5% numerator
TMH	About 0.2–0.3 mm often used as a guide; <0.2 mm raises concern for low reservoir	Age, site, viewing geometry and recent drops affect the result. In one lens-wear study the CA-800 read higher than a Topcon 3D OCT-2000
Blink rate	Often roughly 10–20/min in quiet awake conditions	Task-dependent; rate does not describe completeness
Meibography / staining	Minimal structural loss and absent/minimal staining are favourable	Use age context, gland function and a named dropout or staining scale
Anterior corneal HOA RMS	~0.48 ± 0.12 µm at 6 mm on one Placido device in 228 eyes	Aperture-, device- and term-set-dependent. Orientation only
KPI/CLMI, SAI, SI, AGC, SD, RMS, elevation	No transferable universal numerical cutoff verified for the CA-800 implementations reviewed	Use the software class where provided, repeated morphology, stated analysis settings and clinical correlation

Sources: [1], [4–12], [17–18], [21–22], [35]. These are reference aids, not a single manufacturer normative database.

30 Twenty ways to misread a CA-800 report

A checklist to run before a report changes a decision. Each item names the error, the section that explains it, and the correction.

1. Reading colour before the numerical legend and scale. *Reading the corneal map.* Confirm absolute versus normalised scale and the step.
2. Treating a normalised-scale map from a prior visit as comparable to today's. *Comparison and progression.* Match scales before comparing.
3. Accepting a single "best" frame without checking repeat agreement of shape and axis. *Acquisition.* Obtain and compare repeats.
4. Interpreting a peripheral finding where ring coverage was absent. *Acquisition.* Interpolated points are not measurements.
5. Applying a K >47 D, I-S >1.4 D or KISA% threshold to the CA-800 KC tab. *Keratoconus screening indices; cross-device section.* Use the software class.
6. Reading the P-tab "KC" as a keratoconus flag. *WTW and P tab.* It is central keratometry.
7. Reading CLMI "D" as dioptres. *CLMI.* It is cone diameter in mm.
8. Treating a green KC class as clearance for refractive surgery. *Worked example 6.* It is an anterior-surface screen only.
9. Applying the Pentacam Belin/Ambrósio elevation-difference limits to the HEIGHT report. *Height and elevation.* Different parameter, surfaces, method and reference.
10. Comparing HEIGHT residuals across visits with different reference surfaces or fit diameters. *Height and elevation.* Fix the reference and diameter.
11. Comparing RMS values at different analysis apertures. *Zernike.* State and match the aperture.
12. Comparing the CA-800 "High Order" total to another device's HOA RMS without checking included terms. *Optical quality.* Confirm the term set.
13. Reading "> 20 s" as 20 s, or as missing data. *Tear breakup fields.* It is a censored lower bound.
14. Charting the 5% Level TBT as "NIBUT" without naming the endpoint. *Tear breakup.* Name it every time.
15. Comparing a CA-800 5% time with a Keratograph first-break time as if they were the same measurement. *Worked example 5.* They are not.
16. Reading Δ 5% Level TBT as change since the last visit. *Tear breakup.* It is the average across included acquisitions.
17. Concluding from OPI ≥1 that the surface is protected. *Blinking and OPI.* Focal early breakup can precede the 5% endpoint.
18. Applying the 0.2 mm OCT-derived TMH guide directly to a CA-800 caliper reading. *Tear meniscus height.* The one published comparison found the CA-800 higher than an OCT platform.
19. Reporting meibography loss as a grade without naming the scale, or pooling lids. *Meibography.* Name the scale and the lid.
20. Treating the toric-module axial length or ACD as CA-800 measurements. *Toric IOL module.* They were entered.

31 Parameter index

Each entry gives the report where the parameter appears and the section of this guide that explains it.

Parameter	Report	Section
ACD	Toric IOL	Toric IOL module
AGC	KC/AK tab	Keratoconus screening indices
AK	KC/AK tab	Keratoconus screening indices
AL	Toric IOL	Toric IOL module
APP / Pupil Avg	I tab; P tab	Keratorefractive indices; WTW and P tab
Area of Loss %	MEIB	Meibography
Asphericity (Q, e, p, SF)	I tab; asphericity panel	Asphericity
Asymmetry (A)	I tab	Keratorefractive indices
Astigmatism at 3 / 5 mm	I tab	Keratorefractive indices
Axial map	MAP	Reading the corneal map
Base curve (BC)	Lenses	Contact lens fitting simulation
Best Fit Diameter	HEIGHT	Height and elevation
Blink/min; #Total Blink	Blink	Blinking and OPI
Broken sectors %	TBT	Tear breakup fields
Coma	ZER	Zernike; Optical quality
Cone area (A), diameter (D), RND	KC/CLMI	CLMI
Curvature Irreg. SD	I tab	Keratorefractive indices
Cylinder / axis	K tab	Keratometry
DIFF / COMP	Comparison	Comparison and progression
DSI	CLMI	CLMI
Duration; > Duration	TBT; Blink	Tear breakup fields; Blinking
FBUT / TBUT	FLUO (manual)	Fluorescein
Height / elevation	HEIGHT	Height and elevation
High Order map	ZER	Optical quality
IBI Average / SD	Blink	Blinking and OPI
IL	Toric IOL	Toric IOL module
K1 / K2 / Km / Sim-K	K tab	Keratometry
KPI / Kpi; green/yellow/red class	KC/AK tab	Keratoconus screening indices
La / Lt; Ma / Mt	CLMI	CLMI

Parameter	Report	Section
LSA	I tab; ZER	Keratorefractive indices; Optical quality
OPD map / total RMS	ZER	Optical quality
OPI	Blink	Blinking and OPI
Photopic / mesopic / scotopic diameter	PUP	Pupillometry
PPK	CLMI	CLMI
PSF / spot diagram	ZER	Optical quality
Pupil centre x/y; Pupil-centre SD; Pupil Dec.	PUP; P tab	Pupillometry; WTW and P tab
R0 / Ro; R10–R30	Asphericity panel	Asphericity
Radius Flat / Toricity / Asphericity (reference)	HEIGHT	Height and elevation
SAI	I tab	Keratorefractive indices; cross-device section
Sector time map	TBT	Tear breakup fields
SEQ	Toric IOL	Toric IOL module
SI	KC/AK tab	Keratoconus screening indices
SIA	Toric IOL	Toric IOL module
Surface SD	Asphericity panel	Asphericity
Tangential map	MAP	Reading the corneal map
TBT 5% Level; Δ 5% Level	TBT Summary	Tear breakup
TMH caliper / Avg / Min / Max / SD	TMH	Tear meniscus height
VD	Lenses	Contact lens fitting simulation
Visus / low-contrast simulation	ZER	Optical quality
WTW; WTW x/y offset	Screenshot / P tab	WTW and P tab
Zernike coefficient; analysis pupil	ZER	Zernike

32 Abbreviations and what is not measured

Abbreviation	Meaning
AK / AGC	Apical curvature / apical gradient of curvature
APP / LSA	Average pupil-area corneal power / longitudinal spherical aberration
BAD-D	Belin/Ambrósio Enhanced Ectasia Display final deviation value (Pentacam)
K / KC / KPI	Keratometry; KC can mean keratoconus or central keratometry depending on the panel; KPI is a screening probability index (CA-800) or the Klyce/Maeda index (TMS)
KISA%	Rabinowitz videokeratography keratoconus index
SI / SAI / SD	Inferior–superior sampling difference / surface asymmetry index / standard deviation or residual irregularity, depending on context
SRI	Surface regularity index (TMS)
CLMI / DSI / PPK	Cone Location and Magnitude Index / Differential Sector Index / Percent Probability Keratoconus
OPD / RMS / HOA	Optical path difference / root mean square / higher-order aberrations; check the terms included in the software group
TBT / NIBUT / NIKBUT / FBUT	Tear breakup time / non-invasive breakup time / non-invasive Keratograph breakup time / fluorescein breakup time; endpoints are not necessarily equivalent
IBI / OPI / TMH	Interblink interval / Ocular Protection Index / tear meniscus height
MEIB / ROI / WTW	Meibography / region of interest / white-to-white visible corneal diameter
AL / ACD / SIA / IL	Axial length / anterior chamber depth / surgically induced astigmatism / incision location
BC / VD / SEQ	Base curve / vertex distance / spherical-equivalent field; confirm its planning role in the installed module
OSDI-6	Six-item Ocular Surface Disease Index used for DEWS III screening

Do not infer these from a CA-800 report

Direct posterior corneal elevation; central or thinnest pachymetry; epithelial thickness; endothelial cell count; IOP or corneal biomechanics; direct total ocular aberrometry; axial-length acquisition; retinal/OCT structure; automated gland expressibility or secretion quality; tear osmolarity; MMP-9; lipid-layer thickness. These require other examinations or instruments unless a separate external result is explicitly supplied.

> **Units:** 1 mm = 1,000 µm. For conventional keratometric index n = 1.3375, K(D) = 337.5 / r(mm). Thus r = 8.00 mm corresponds to 42.19 D. This equivalent keratometric power is not a direct measurement of both corneal surfaces.

Sources: [1–2].

33 Claim-source register

The register lists the numerical claims and thresholds in this guide, where each comes from, and how much weight it can carry. It is the document a clinical reviewer should check first.

Claim	Source	Status
CA-800: 24 rings, 6,200 measured points, >100,000 analysed, coverage to 9.8 mm	Manufacturer product page [20]	Manufacturer-stated; not independently measured
CA-800 5% Level TBT definition; Δ 5% is an average of included acquisitions	Manual [1] §14.11	Device-defined
Automatic restart on a second blink within 5 s; 30 s maximum acquisition; blink recording maximum 5 min	Manual [1] §§13.9.3–13.9.4	Device-defined
Pupillometry phase settings 500–5,000 ms	Manual [1] §14.6	Device-defined
Toric module formulas: Haigis, Hoffer Q, SRK II, SRK/T, Holladay I	Manual [1] §16.2	Device-defined
KPI green/yellow/red numerical boundaries	Not documented in reviewed manual	No validated cutoff
NIBUT <10 s; OSDI-6 ≥4; osmolarity ≥308 or interocular >8 mOsm/L; staining >5 corneal / >9 conjunctival spots / lid margin ≥2 mm and ≥25%	TFOS DEWS III abstract [4]	Clinical reference (consensus). Endpoint equivalence to CA-800 5% not established
CA-800 NIBUT repeatability 5.4 s, ICC 58.6%; median 3.3 vs 8.1 s subjective	Valencia-Nieto 2024 [15]; correction [16] content unverified	Clinical reference; pre-lens tear film with soft lenses in situ; not a lens-off figure; provisional until the correction is checked
CA-800 NIBUT vs OSDI r = –0.11	Potenza 2026 [22]	Clinical reference
CA-800 mean BUT 3.18 ± 2.0 s in 44 students	Uzun 2022 [23]	Clinical reference; symptomatic sample recruited for ocular-surface complaints, aged 15–25
CA-800 TMH repeatability 0.07 mm, ICC 0.93; 0.22 vs 0.17 mm vs Topcon 3D OCT-2000	Valencia-Nieto 2024 [21]	Clinical reference; one comparison in contact-lens wearers against one OCT platform
Keratograph measures first break anywhere on the cornea; 12.35 ± 7.45 s shorter than Tearscope	Best 2012 [24]	Clinical reference, Keratograph only

Claim	Source	Status
Pentacam BAD-D bands 1.6 / 2.6; Belin/Ambrósio elevation-difference limits anterior 5 / 7 µm, posterior 12 / 16 µm	OCULUS interpretation guide [25], printed p. 36	Manufacturer-defined, Pentacam only; difference between standard and enhanced reference maps, not raw elevation
BAD-D v3/v4 empirical cutoffs ~1.8–1.9	Lopes 2024 [27]	Clinical reference, Pentacam only
ABCD normative: ARC 7.65 ± 0.236 mm, PRC 6.26 ± 0.214 mm, thinnest 534.2 ± 30.36 µm (672 eyes)	Belin and Duncan 2016 [26]	Clinical reference, Pentacam only
KISA% cutoff 100; suspect range 60–100; 280/281 correctly classified; K adjusted at 47.2 D, absolute values, floor of 1	Rabinowitz and Rasheed 1999 [28]; calculation rules as restated in [48]	Clinical reference, videokeratography of that era
Klyce/Maeda KPI validation sensitivity 89%, specificity 99%	Maeda 1994 [29]	Clinical reference, TMS-1
KPI >0.23 suggestive; SRI <0.56 normal (TMS)	Cavas-Martínez 2016 [30]	Secondary source
I-S >1.4 D; central K >47 D	Attributed via Kuo 2020 [46]	Secondary attribution; primary wording unverified
Consensus 2015: posterior elevation and thickness distribution mandatory; 2025 review found evidence lacking for subclinical claim	Randleman 2025 [32] quoting Gomes 2015 [13]	Clinical reference; Edition 2 (2026) statements unverified [33]
Arita meiboscore 0–3 definitions; 236 volunteers; R = 0.428 with age	Arita 2008 [17]; definitions restated in Arita 2021 [47]	Clinical reference
Pult five-grade scale 0 / <25 / 26–50 / 51–75 / >75%	Pult 2013 [34]	Clinical reference
Anterior corneal HOA RMS 0.479 ± 0.124 µm at 6 mm (228 eyes, Atlas)	Wang 2003 [35]	Clinical reference, different device
Normal epithelium 52.3 ± 3.6 µm central; PSD cutoff 0.057	Li 2012 [36]	Clinical reference, RTVue OCT
Epithelial thickness not interchangeable across OCT devices; ~4 µm offset	Feng 2023 [37]	Clinical reference
Healthy anterior Q –0.24 ± 0.10 at 6 mm	Al-Somali 2023 [6]	Clinical reference, Pentacam
Pupil 5.39 / 4.70 / 2.84 mm at 0 / 4 / 250 lux	Rickmann 2017 [7]	Clinical reference, research pupillometer
WTW 11.95 ± 0.39 mm	Alotaibi 2025 [8]	Clinical reference, Pentacam AXL Wave

Claim	Source	Status
TMH varies with method and age; some healthy elderly <0.2 mm	Doughty 2002 [9]	Clinical reference
Comparator instrument specifications (ring counts, points, coverage)	Manufacturer pages and manuals [39–45]	Manufacturer-stated
ISO 19980:2021 specifies minimum requirements for corneal topographers	ISO [38]	Standard; content not reproduced

34 References

Device-specific descriptions are anchored to the manufacturer manual. Broader clinical reference values are identified separately; none of the external normative studies is presented as a CA-800 normative database. Evidence reviewed through 19 September 2026. For a field that differs from this edition, use the installed-version manual and manufacturer clarification before applying a threshold.

Device and normal-value context

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35 One-page summary

What the CA-800 measures. The anterior corneal surface by Placido reflection; tear-film stability, meniscus height and blink behaviour over that surface; pupil diameter and dynamics under programmed light; meibomian gland structure by infrared; fluorescein pattern by blue light. It does not measure the posterior cornea, thickness, epithelium, biomechanics, IOP, osmolarity or the retina.

Reading order. Acquisition validity → what the field actually describes → like-for-like comparison → what would confirm or challenge it.

If the report shows	Then	Do not
Green KC class	Anterior pattern not compatible with keratoconus on this scan	Treat it as surgical clearance or as exclusion of posterior or thickness abnormality
Yellow or red KC class	Repeat with good quality; review lens history and surface; obtain tomography and pachymetry	Apply K >47 D, I-S >1.4 D, KISA% or BAD-D thresholds to it
HEIGHT residual	Anterior departure from the selected reference at the selected diameter	Compare with Pentacam elevation-difference limits or across different references
Zernike RMS	Anterior corneal aberration at the stated aperture and term set	Compare across apertures or with another device's HOA total
5% Level TBT	Time to 5% of sectors broken; Δ is the average of included acquisitions	Chart as "NIBUT" without the endpoint, equate to first-break, or read Δ as change
> Duration	Endpoint not reached; a lower bound	Convert to the duration value or to zero
OPI ≥ 1	5% endpoint after mean blink interval	Conclude the surface is protected from focal early breakup
TMH < 0.2 mm	Possible low reservoir; corroborate	Diagnose aqueous deficiency from one image; the one published comparison found the CA-800 higher than an OCT platform
Meibography % loss	Visible structural loss in the selected region	Report as a grade without naming the scale; infer secretory function
Toric module AL, ACD	Entered external values	Treat as CA-800 measurements

Orientation values, not thresholds. Central K ~43–44 D; anterior Q ~ –0.2 to –0.3; WTW ~11–12.5 mm; photopic pupil ~2–4 mm, scotopic ~4–8 mm; blink rate ~10–20/min; TMH guide ~0.2–0.3 mm; anterior HOA RMS ~0.48 µm at 6 mm on one Placido device.

The DEWS III sign. OSDI-6 ≥4 plus NIBUT <10 s (or hyperosmolarity, or staining thresholds) gives a diagnosis of dry eye. Record which NIBUT endpoint the CA-800 reported; the 5% level is not formally the same measurement.

Published CA-800 reliability. NIBUT repeatability ~4–7 s measured through a soft lens (no lens-off figure published), shorter than a subjective method in that study, weakly related to symptoms. TMH repeatability 0.07 mm; higher than a Topcon OCT in the one published comparison.

Next examination when the question exceeds the device. Scheimpflug or OCT tomography for posterior surface and thickness; epithelial mapping for early ectasia; osmolarity and lid examination for dry-eye mechanism; a validated pupillometer or neuro-ophthalmic assessment for abnormal pupils.

NETRA CLINICAL KNOWLEDGE HUB

Reading the CA-800 Report · Edition 3.1 · September 2026
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