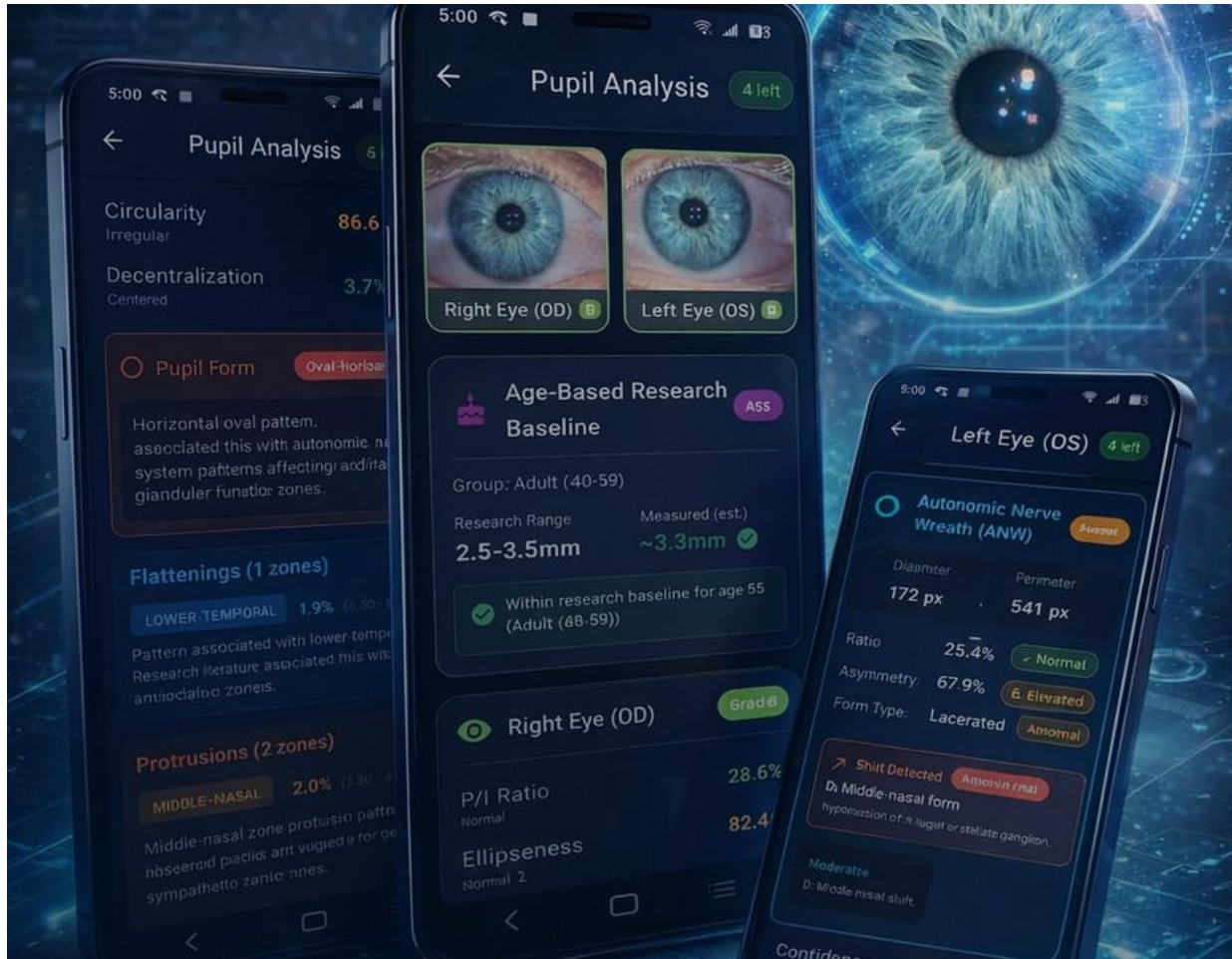


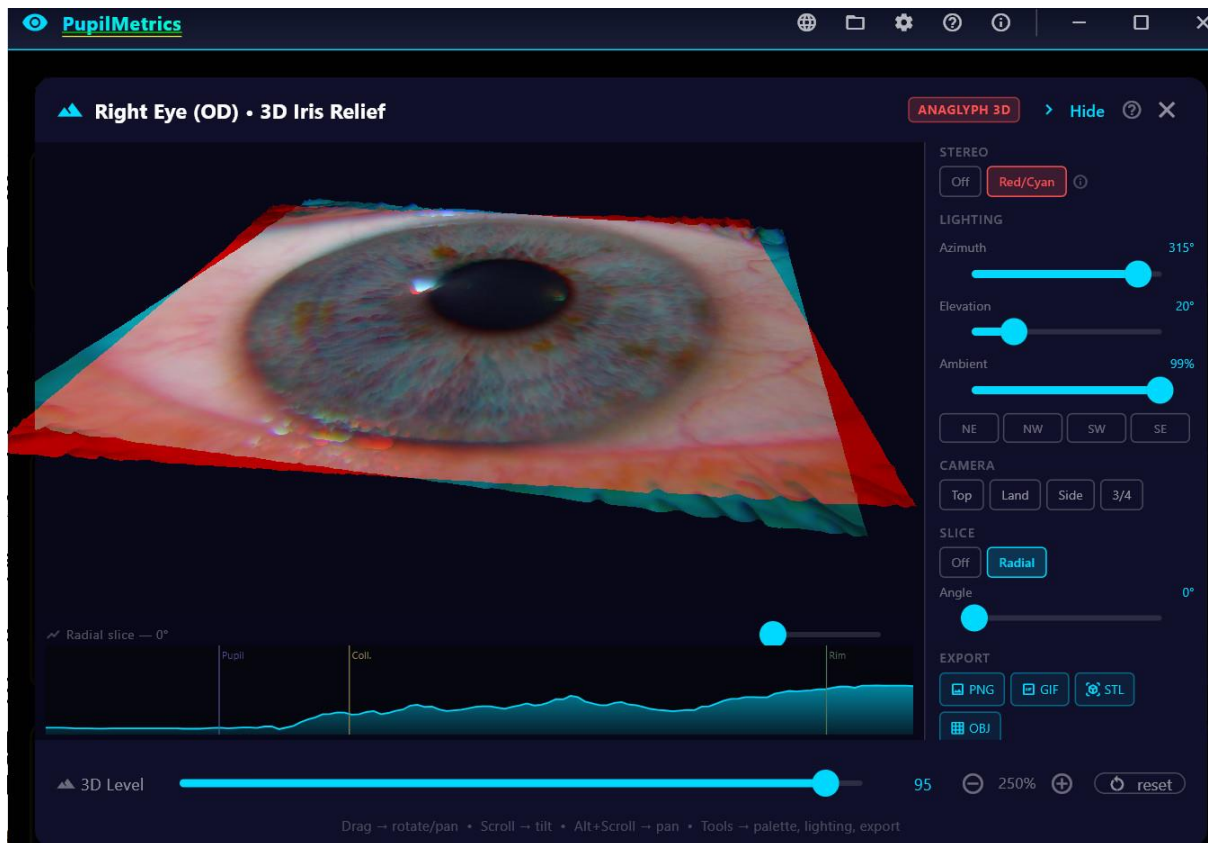
PupilMetrics Version 6.1 - English

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PupilMetrics is a comprehensive, AI-enhanced platform designed for iridologists, naturopaths, functional medicine practitioners, herbalists, chiropractors, and researchers who seek deeper insights into autonomic nervous system balance, constitutional patterns, and reflexive organ correlations through the iris and pupil.

Built on decades of iridology tradition combined with modern computer vision and image processing, PupilMetrics delivers fast, objective, and reproducible measurements - including P/I Ratio, ANW (collarette) assessment, pupil decentration, zone-specific flattenings and protrusions, and advanced texture & structural analysis tools. Whether you are conducting clinical sessions, teaching constitutional iridology, or performing comparative research, the app provides clear, visual, and exportable data to support your practice and educational work.



Why Institutions & Healing Arts Practitioners Choose PupilMetrics

- Clinical Workflow Efficiency - From high-quality image capture (with automatic quality gating or professional Dino-Lite iridoscope integration) to instant multi-metric analysis and professional PDF reports.
- Educational & Research Depth - Advanced toolkit including iris unwrapping (Daugman normalization), 3D relief viewer, pigment density mapping, Gabor/LBP texture analysis, PLR kinetics, constitutional typing, and more - perfect for classrooms, student training, and peer-reviewed exploration.
- Natural Medicine Integration - Therapy recommendation panels (herbal, nutritional, chiropractic, and TCM correlations) that link iris findings directly to practical support strategies.
- Compliance & Transparency - Full disclaimers, offline capability after activation, data privacy controls, and export options (PDF, JSON, Excel, TXT) for documentation and research archiving.

PupilMetrics bridges classical iridology with contemporary technology, empowering practitioners and educators to observe, document, and discuss iris signs with greater confidence and clarity - all while maintaining the art and science of holistic assessment.

Intended for educational, research, and wellness-support use. Not a medical diagnostic device.

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1. Getting Started

1.1 System Requirements

Platform Minimum Requirements
----- -----
Windows (primary) Windows 10 64-bit, 4 GB RAM, USB 2.0 port for iriscopes
Android Android 8.0+, USB OTG support for iriscopes
iOS iOS 14

An internet connection is required for initial license activation on Windows. Subsequent use is fully offline.

1.2 Installation

****Windows Desktop****

1. Run the PupilMetrics installer (`PupilMetrics_Setup.exe`).
2. The installer places the application in `Program Files\PupilMetrics` and creates a desktop shortcut.
3. If using a Dino-Lite iriscope, ensure the ****DNVideoX**** driver is installed before launching (see Section 2.5).

****Android****

Install from the Google Play Store or load the provided APK.

****MAC OS****

Install directly from cnri.edu.

1.3 Licensing

Windows – License Tiers

PupilMetrics uses a machine-bound license on Windows. On first launch you are prompted to start a free trial or enter a license key.

Tier	Duration	Machines
Trial	14 days, full features	1
Standard	1 year	1
Professional	Lifetime	1
Enterprise	Lifetime	Multiple

****Starting the free trial****

Click ****Start Free Trial**** on the license screen. The 14-day countdown begins immediately. All features are available during the trial – no credit card required.

****Entering a license key****

1. Purchase a license key from CNRI.
2. On the license screen, paste your key into the ****License Key**** field and click ****Activate****.
3. Activation contacts `licenses.cnri.edu` to bind the key to your machine ID.
4. Once activated, PupilMetrics works offline indefinitely.

****Trial expired****

If your trial expires, the license screen appears at startup. Enter a purchased license key to restore full access.

> ****Note:**** Moving a license to a new machine requires contacting CNRI support to unbind the old machine ID.

Android & iOS – In-App Purchase

On mobile, licensing is handled through the App Store / Google Play via RevenueCat. Tap ****Subscribe**** or ****Purchase**** on the paywall screen to unlock the full app.

1.4 First Launch

After licensing, the app follows this flow every time it is opened:

License Check

↓

Splash Screen

↓

Patient Information Screen ← enter name, DOB, notes

↓

Camera Mode Selector ← choose how to capture each eye

↓

Eye Capture (Right then Left)

↓

Analysis & Results Screen

****Patient Information Screen****

Fill in at minimum the patient's name before proceeding. Date of birth is used for age-normalized PI ratio interpretation. Observer notes entered here are included in PDF and text exports.

1.5 Desktop Window & Keyboard Shortcuts

On Windows, PupilMetrics uses a custom title bar with minimize, maximize, and close controls. The window can be resized freely.

Shortcut	Action
`F11`	Toggle fullscreen
`Ctrl + H`	Open scan history
`Escape`	Go back / close dialog

The ****Natural Medicine**** settings panel (herbal, nutrition, chiropractic, TCM toggles) and the ****Clinic/Practice Name**** field are accessible from the settings icon in the title bar on any screen.

2. Capturing Eye Images

2.1 The Capture Workflow

PupilMetrics always captures ****right eye first (OD)****, then ****left eye (OS)****. This convention matches standard clinical iridology notation. Both images must be captured before analysis can run.

The Camera Mode Selector screen lets you choose the capture method independently for each eye, though in practice the same source is used for both.

2.2 Camera Source Selection

Tap the eye card on the Camera Mode Selector to open the source picker. The following sources are available:

Mode	Best For
Quality-Gated Rear Camera	Phone/tablet – automatic sharpness & exposure gate
Quality-Gated Front Camera	Selfie capture on mobile
Manual Camera	Direct camera control, manual shutter
USB / UVC Iriscope (Dino-Lite)	Professional iriscope via USB
PLR Video Mode	Pupillary light reflex (video analysis)
Import from Gallery	Re-analyse a previously saved iris photo

2.3 Quality-Gated Camera Mode




The quality-gated modes are the recommended capture method on phones and tablets. A real-time quality analyser checks every frame before accepting it, preventing blurry or poorly-exposed images from entering analysis.

****How it works****

The gate evaluates each camera frame against five criteria simultaneously:

Criterion	Acceptable Range	What it catches
Sharpness	Score ≥ 100	Motion blur, out-of-focus iris
Brightness	30 - 230 (0-255 scale)	Under- and over-exposure
Contrast	Score ≥ 30	Flat, low-detail images
Pupil confidence	$\geq 30\%$	Frame contains a detectable pupil
Centre offset	$\leq 25\%$ of frame	Pupil not centred enough

****Status indicators****

-  Red border + live feedback message – one or more criteria failing; hold still and adjust position
-  Amber – borderline; minor adjustment needed
-  Green border – all criteria met; photo is captured automatically

****"Not an Eye" rejection****

Even after automatic capture, a secondary AI check confirms the image contains an iris/pupil. If a non-eye image is detected (fingers, floor, clothing), a warning dialog appears with the option to retake.

****Tips for best results****

- Stabilize the device – even small hand movement drops sharpness below threshold.
- Ensure even lighting; avoid direct sunlight on one side.
- Position the iris in the center of the frame before getting close.
- Allow 2-3 seconds for the auto-exposure to settle after moving the camera.

2.4 Manual Camera Mode

Manual mode gives direct access to the camera shutter without the quality gate. Use this when:

- You want full control over the exact moment of capture.
- You are using a third-party macro lens attachment.
- The quality gate is rejecting good images due to non-standard lighting.

Tap the shutter button to capture. The "Not an Eye" check still runs after capture.

2.5 USB / UVC Iriscope (Dino-Lite)

PupilMetrics has deep integration with the **Dino-Lite AM4115ZT** and compatible iriscopes models.

Windows (Dino-Lite via DNVideoX)

Prerequisites

- Install the Dino-Lite **DNVideoX** ActiveX driver from the Dino-Lite website before the first use.
- Connect the iriscopes via USB before launching PupilMetrics.

How it works

PupilMetrics launches a lightweight background bridge process (`dinolite_bridge.exe`) that communicates with the iriscopes via the DNVideoX COM interface. The live preview is displayed in the app.

Capturing

- **MicroTouch button** (recommended): Press the physical button on the Dino-Lite barrel. The image is captured instantly and the app advances to the next eye.
- **On-screen button**: Tap the capture button in the app if the physical button is not accessible.

LED control

The iriscopes LED ring can be toggled and brightness adjusted directly from the capture screen.

Troubleshooting

Symptom	Fix
---------	-----

----- -----	-----
-------------	-------

No camera detected	Unplug and reconnect the USB cable; restart the app
--------------------	---

Black preview	DNVideoX driver not installed; install from Dino-Lite website
---------------	---

MicroTouch button unresponsive	Wait 2 seconds after the preview appears for the button to arm
--------------------------------	--

Android (Dino-Lite via USB OTG)

Connect the iriscopes to your Android device using a **USB OTG adapter**. The app automatically detects the device on the UVC camera screen. A connection status indicator appears at the top of the capture screen. Capture using the on-screen shutter button.

> **Note:** USB OTG must be supported and enabled on your Android device.

2.6 PLR Video Mode

PLR (Pupillary Light Reflex) video mode records the pupil's response to a light stimulus, allowing measurement of constriction speed and amplitude over time.

When to use

Use PLR mode when you need to assess neurological pupil response, not just static iris morphology.

How to capture

1. Select **PLR Video** from the Camera Mode Selector.
2. Choose front or rear camera and which eye.
3. Ensure the room is dim before starting.
4. Tap **Record** – a light stimulus is presented on-screen or externally.
5. The pupil constriction/dilation cycle is recorded and analysed frame-by-frame.

PLR results appear on a separate results screen and are not combined with the standard iris analysis.

2.7 Import from Gallery

Use **Import from Gallery** to load previously saved iris photos for analysis. This is useful for:

- Re-analysing archived patient images.
- Comparing results across sessions using the same raw photo.
- Testing with reference images.

Both eyes at once

A single gallery action prompts for the right eye image, then the left eye image in sequence.

Single eye

If you only have one image, you can import it for the right or left eye individually from the individual eye card on the Camera Mode Selector.

> **Tip:** Gallery images are copied into a PupilMetrics-managed folder so the original file is never modified.

2.8 Tips for a Good Capture

Regardless of capture mode, the following practices produce the best analysis results:

Lighting

- Use diffuse, even illumination – the built-in iriscopes LED ring is ideal.
- Avoid harsh shadows across the iris.
- Avoid reflections from overhead lights on the cornea; slight repositioning eliminates most reflections.

Distance & framing

- The iris should fill at least 50% of the frame width.
- Keep the iris centred; a pupil near the edge of the frame reduces decentration accuracy.
- For the Dino-Lite, the optimal focal distance is approximately 2-3 cm from the eye.

****Stability****

- Rest the device or brace your hand to eliminate motion blur.
- Ask the patient to fixate on a distant point to minimise involuntary eye movement.
- Capture during natural blinking pauses – the image quality gate automatically rejects frames taken during a blink.

****Grade guide****

After analysis, each eye receives a quality grade:

Grade	Meaning
A	High confidence – all metrics within optimal range
B	Good confidence – minor limitations, results reliable
C	Reduced confidence – consider recapture if possible
D	Low confidence – recapture recommended before clinical use

3. Reading the Analysis Results

After both eye captures are processed, PupilMetrics displays a detailed results screen covering six measurement areas. This section explains what each metric means, how it is calculated, and what the values signify clinically.

> **Scope of use:** All measurements are provided as clinical support tools and educational references. They are based on historical iridology and autonomic reflex research. PupilMetrics is not a diagnostic device. Results should always be interpreted by a qualified practitioner in the context of a complete patient assessment.

3.1 The Iris Zone Map

The iris is divided into **eight concentric-radial zones**, mapped by clock position. Each zone has historical associations with autonomic reflexes in corresponding body regions. Zone findings (flattenings, protrusions, ANW shifts) are reported by zone name, not clock position, so the map below is the key reference:

Zone clock positions

Zone	Right Eye (OD)	Left Eye (OS)	Historical associations
Upper-Central	12 o'clock	12 o'clock	Mood regulation, energy patterns (both eyes)
Upper-Nasal	1 o'clock	10-11 o'clock	Cognitive, cervical spine reflexes
Middle-Nasal	2-3 o'clock	9 o'clock	OD: oxygen utilization, cardiac/respiratory · OS: neurological, cardiac
Lower-Nasal	4-5 o'clock	7-8 o'clock	Urogenital, pelvic/lumbosacral zones
Lower-Basal	6 o'clock	6 o'clock	OD: renal, lower extremity · OS: renal, eliminative
Lower-Temporal	7-8 o'clock	4-5 o'clock	OD: hepatic, metabolic · OS: cardiac, splenic
Middle-Temporal	9 o'clock	3 o'clock	OD: respiratory, cardiac · OS: pulmonary, cardiac
Upper-Temporal	10-11 o'clock	1-2 o'clock	OD: cranial nerve, auditory · OS: neurovegetative, speech

> **Note on mirroring:** The temporal and nasal sides swap between eyes. The left eye (OS) is a mirror image of the right eye (OD) – the nasal side of each eye faces the nose.

Interactive zone overlay

The zone map is available as a live polar overlay directly on the iris photo in the Results screen. When **Show zone overlay** is enabled (Settings → §8.3):

- **Tap or click any sector** of the polar chart to identify it. The zone name and its associated organ system are immediately displayed in the info panel directly below the chart image.

- Each tapped zone is **automatically appended** to the Observer Notes field in the format `Zone Name – Organ System`. Tapping the same zone twice will not create a duplicate entry.

- Additional free-text commentary can be typed directly in the Observer Notes field alongside the auto-populated entries. All notes are included in both the TXT and PDF exports under "Observer Notes".

This allows quick zone-to-organ cross-reference during a consultation without leaving the results screen. For structured clinical sign recording, see the **Iris Sign Finder** in §8.3.

3.2 PI Ratio (Pupil-Iris Ratio)

What it is

The PI ratio is the diameter of the pupil expressed as a percentage of the total iris diameter. It is the primary measurement of pupil size relative to the iris.

Formula

PI Ratio = (Pupil diameter ÷ Iris diameter) × 100

****Normal range****

A PI ratio of ****20-30%**** is considered physiologically normal for adults in standard indoor lighting. The app displays an interpreted label alongside the number:

PI Ratio	Label
< 15%	Miosis (very constricted)
15-19%	Constricted
20-30%	**Normal**
31-40%	Dilated
> 40%	Mydriasis (very dilated)

****Age-normalized comparison****

Because pupil size decreases with age, PupilMetrics compares the measured diameter against an age-specific reference range. The patient's date of birth must be entered for this comparison to be shown.

Age Group	Expected Diameter	Normal Range
Infant (< 1 yr)	2.2 mm	2.0 - 2.5 mm
Child 1-5	4.0 mm	3.5 - 4.5 mm
Child 6-11	4.3 mm	3.8 - 4.8 mm
Teen	4.2 mm	3.5 - 5.0 mm
Adult 20-39	3.5 mm	3.0 - 4.2 mm
Adult 40-59	3.0 mm	2.5 - 3.5 mm
Senior 60+	2.7 mm	2.3 - 3.2 mm

The estimated diameter is derived from the PI ratio multiplied by an assumed average iris diameter of 12 mm.

3.3 Zone Findings – Flattenings (FLAT) and Protrusions (PROT)

****What they are****

The pupil margin is assessed for local deviations from a perfect circle. Two types of deviation are detected:

Badge	Shape	Historical interpretation
FLAT	Pupil margin curves <i>*inward*</i> at a zone	Reduced autonomic tone in that zone's reflex area
PROT	Pupil margin <i>*bulges outward*</i> at a zone	Increased sympathetic activity in that zone

****Severity scale****

Each finding is graded by the percentage deviation from the expected circular margin:

Severity	Deviation	Meaning
Within limits	1.5-3.0%	Minor variation, not clinically flagged
Mild	3.0-6.0%	Notable deviation, noted for observation
Moderate	6.0-10.0%	Significant deviation, worth follow-up
Significant	> 10.0%	Strong deviation, primary clinical focus

Deviations below 1.5% are not reported. Each zone card shows the severity percentage, the zone name, the eye (OD/OS), and the historical organ association for that zone.

3.4 ANW Assessment (Collarette / Autonomic Nerve Wreath)

****What the ANW is****

The ANW (Autonomic Nerve Wreath), also called the collarette, is a textured ring visible in the iris approximately one-third of the way between the pupil and the iris rim. It marks the transition between the inner and outer iris zones and reflects autonomic nervous system tone.

****ANW Ratio****

The ratio measures the ANW ring diameter relative to the iris diameter.

ANW Ratio	Status	Autonomic interpretation
< 25%	**Spastic**	ANW ring contracted inward – sympathetic dominance, hypertonicity
25-35%	**Normal**	Balanced autonomic tone
> 35%	**Atonic**	ANW ring expanded outward – parasympathetic dominance, hypotonicity

****ANW Asymmetry****

The asymmetry between OD and OS ANW ratios is also measured. An asymmetry of ****0-5%**** is normal. A larger asymmetry, particularly where one eye is Spastic and the other is Atonic, is flagged as a ****Functional Frustration**** pattern.

****ANW Shifts****

Local sectors of the ANW ring that deviate inward or outward from their expected position by more than ****8%**** are reported as ANW Shift findings (badge: ****ANW****). Like FLAT/PROT findings, each shift is mapped to a clock zone and assigned its historical organ association.

****Bilateral comparison****

After both eyes are analysed, the bilateral ANW summary compares OD and OS ratios side-by-side, calculates the asymmetry, and flags the functional frustration pattern if present.

3.5 Decentration (Pupil Position)

What it is

Decentration measures how far the pupil center is offset from the geometrical center of the iris, expressed as a percentage of the iris radius.

Decentration	Classification
< 5%	Normal – pupil centered within physiological limits
≥ 5%	Notable – decentration flagged with directional pattern

Directional patterns

When decentration is notable, the direction is reported as a named pattern:

Direction	Pattern name	Zone implication
Toward nose	Nasal	OD: pulmonary reflexes · OS: cardiac reflexes
Away from nose	Temporal	Renal, reproductive zones
Upward	Frontal	Cerebral, cognitive zones
Downward	Basal	OD: intracranial pressure reflexes · OS: cerebral patterns
Upper-inward	Upper-nasal	OD: hepatobiliary · OS: splenic, diaphragmatic
Upper-outward	Upper-temporal	Renal, reproductive zones

The decentration angle is also reported in degrees (0-360°) from the horizontal, providing precise directional information for charting.

3.6 Ellipseness (Pupil Shape)

****What it is****

Ellipseness measures how circular the pupil is, expressed as the ratio of the pupil's minor axis to its major axis (100% = perfect circle, lower = more elliptical):

Ellipseness	Classification
≥ 95%	**Normal** – essentially circular
< 95%	**Anomaly** – pupil form deviation detected

****Pupil form types****

When ellipseness falls below the normal threshold, the orientation of the ellipse is assessed to determine the form type:

Form	Description	Historical association
Circle	Normal round pupil	No pattern
Horizontal oval	Wider than tall	Respiratory/glandular autonomic zones
Vertical oval	Taller than wide	Cerebral circulation zones
Diagonal oval	Tilted ellipse	Urogenital zone reflexes
Chord-like	Flat edge on one side	Localized autonomic influence
Irregular	Non-uniform distortion	Multiple autonomic zone influences

3.7 Anisocoria (Pupil Size Difference)

****What it is****

Anisocoria is the difference in pupil size between the right and left eye, expressed as an absolute percentage difference in PI ratio.

Absolute difference	Severity	Clinical note
< 2%	None	– within normal limits Physiologically symmetric
2-4%	Mild	May be physiological; monitor
4-8%	Moderate	Notable asymmetry; flagged for observation
> 8%	Severe	Significant asymmetry; research observation flagged

Moderate and severe anisocoria activates a TBI (Traumatic Brain Injury) indicator flag, which is noted in the results and PDF report. This flag is a research observation reference, not a diagnostic finding.

The larger pupil (OD or OS) and the absolute difference are displayed in the bilateral comparison card.

3.8 Confidence Scores & Hybrid Fusion

PupilMetrics runs **two independent analysis pipelines** on every image and then fuses their outputs into a single confidence score.

Classical CV (pixel-based)

The classical computer vision pipeline uses circle detection, radial sampling, and boundary-point analysis on the full-resolution image. It produces pixel-accurate iris and pupil boundaries.

ML Model (ONNX)

The machine learning model (`cnri_model.onnx`) is a neural network trained on iris images, resized to a normalized 224x224 crop centered on the detected iris. It outputs four regression values: PI ratio, decentration, ellipseness, and decentration angle.

****Hybrid Confidence Formula****

The four components are weighted and combined:

Component	Weight	What it measures
Capture quality	20%	Image sharpness, brightness, contrast from the quality gate
Classical CV confidence	35%	Circle detection score from the Hough-like iris finder
ML plausibility	20%	Whether the ML outputs fall within anatomically reasonable ranges
Cross-model agreement	25%	How closely the two pipelines agree on PI ratio (80%), ellipseness (10%), and decentration (10%)

The fused confidence is displayed as a percentage and maps to the familiar grade:

Fused confidence	Grade
> 75%	**A**
60-75%	**B**
45-60%	**C**
< 45%	**D**

****Safety caps****

If classical CV confidence falls below 25%, or if capture quality falls below 30%, the fused score is capped at 40% or 50% respectively, regardless of other components. This ensures a poor underlying image always produces a conservative grade.

****When the two pipelines disagree****

When the classical and ML results differ significantly on PI ratio (> 10% tolerance), the agreement component reduces the hybrid score. The individual classical and ML values are still shown in the results for reference when "Show ML Comparison" is enabled in settings.

3.9 Scan History

Every completed analysis is automatically saved to the local database. Access past scans via:

- **Keyboard shortcut:** `Ctrl + H` (Windows)
- **Scan History button** on the results screen

Each history record stores the full analysis result including all metrics, zone findings, ANW assessment, PDF path, and patient information. Records can be reopened to view the full results or regenerate a PDF.

3.10 Visual Analysis Tools

The Analysis Results screen provides six optional visual tools that can be activated from the chip bar and button row below the iris images. These tools are non-destructive – they do not alter the stored analysis data; they are overlays and viewers only.

3.10.1 CLAHE Contrast Enhancement

What it does

CLAHE (Contrast Limited Adaptive Histogram Equalization) enhances local contrast across the iris image by equalizing the histogram in small overlapping tiles rather than globally across the whole image. The effect is to bring out crypts, fiber texture, lacunae, and zone boundary detail that may be washed out in the original capture, without blowing out bright regions.

How to use

Tap the **Enhance** chip on the analysis screen. The chip toggles between the original and the enhanced image. Processing runs in a background isolate (separate execution thread) so the UI remains responsive during the computation.

****When it helps****

- Dark haematogenic irides where fiber detail is difficult to see against the dense brown stroma
- Over-exposed images where the pupil-iris boundary is soft
- Checking fine structural detail – crypts, radial sulci, small lacunae – before constitutional assessment

****What it does not change****

CLAHE is a display operation only. The contrast-enhanced image is shown on screen but is not used by the analysis pipeline. All metrics (PI ratio, zone findings, ANW, etc.) are derived from the original captured image regardless of whether the Enhance chip is active.

> ****Tip:**** CLAHE is particularly useful when examining constitutional type features. Toggle it on before assessing fiber texture (tight vs. loose), tophi definition, and lacuna patterns.

3.10.2 Iris 3D Relief Viewer

****What it does****

The 3D Relief viewer renders the iris as an interactive 3D height-map terrain – each pixel's luminance is mapped to an elevation value, producing a landscape where brighter iris regions (raised fibers, tophi, projections) appear as high ground and darker regions (crypts, lacunae, sulci) appear as valleys.

The rendering engine downsamples the image to a 512 × 512 working resolution and builds a 128 × 128 triangle mesh, drawn as a filled 3D surface in a single frame. The color texture is taken directly from the original iris image, so all pigmentation detail is preserved in 3D.

****Opening the viewer****

Tap the ****3D Relief**** chip on the analysis screen. The viewer opens as a full-screen dialog (740 × 640 px).

****Controls****

Input	Action
Mouse drag (horizontal)	Spin the model around the vertical (Y) axis
Mouse drag (vertical)	Pan the model up/down
Scroll wheel	Tilt the view angle (steeper / shallower landscape angle)
Alt + Scroll wheel	Pan vertically
3D Level slider (1-100)	Height exaggeration – low values = stronger relief, high values = flatter
Zoom - / + buttons	Zoom in or out (25%-400%)
Reset button	Restore the default view angle, zoom, and pan

****Default view****

The viewer opens at a ~56° tilt angle, no Y-rotation, 3D Level 35 (moderate relief), and 100% zoom. This provides a comfortable landscape view of the full iris.

****Clinical insight from 3D Relief****

The height-map surface makes several structural features more visually apparent than in the flat 2D image:

Feature	Appearance in 3D
Lacunae (crypts)	Deep valley pits or craters
Tophi	Rounded mounds or ridges on the stroma surface
Radial fibers	Ridge-and-valley corrugation radiating outward from the collarette
Collarette (ANW)	Raised ring separating the inner pupillary zone from the ciliary zone
Pigment concentration	Elevated terrain where pigment density is highest
Scurf rim	Thickened peripheral ridge at the iris border

> **Note:** The 3D Relief view is for observational and educational purposes. Structural depth in the height map reflects luminance difference, not true anatomical depth. Dense pigmentation may appear artificially elevated because the stroma beneath it is darker; this should be interpreted with that caveat in mind.

3.10.3 Pigment Density Heatmap

What it does

The pigment density heatmap applies a thermal colour scale to the iris image, replacing the natural colour of the iris with a spectrum from dark blue (lowest local luminance / pigment density) through cyan, green, yellow, and orange to bright red (highest local luminance / pigment concentration).

The heatmap highlights the spatial distribution of pigment across the iris surface, making it easy to identify localized pigment concentrations, heterochromia sectors, and ciliary zone darkening that may be subtle in the normal colour view.

Opening the heatmap

Tap the **Heatmap** chip on the analysis screen. The chip toggles the thermal overlay on and off over the iris image.

Reading the colour scale

Colour	Meaning
--------	---------

----- -----	
-------------	--

Dark blue / black	Very low pigment density – typically the pupil area or pale iris stroma
--------------------------	---

Cyan / blue	Low-to-moderate density
--------------------	-------------------------

Green	Moderate density
--------------	------------------

Yellow / orange	Elevated density – common in biliary/mixed constitutions
------------------------	--

Bright red	Highest local density – concentrated pigment deposits, scurf rim, tophi deposits
-------------------	--

****Clinical applications****

- ****Constitutional assessment**** – Identifies the pigment pattern type (uniformly dense = haematogenic, concentrated peripherally = biliary/mixed, sparse = lymphatic)
 - ****Heterochromia sectors**** – Colour asymmetries appear as wedge-shaped hot spots that are easy to locate even in dark irides
 - ****Scurf rim**** – The darkened peripheral rim becomes a distinctive bright red band in the heatmap
 - ****Liver-zone pigments**** – Concentrated pigment in the 7-9 o'clock sectors (OD) shows clearly as an orange-red zone in the temporal quadrant
- > ****Note:**** The heatmap encodes luminance, not a direct measurement of chemical pigment concentration. High-reflectance artefacts (corneal reflex, specular highlights) may produce false hot spots. Assess any unexpected bright areas in the context of the original image.

3.10.4 Annotation Mode

****What it does****

Annotation mode allows the practitioner to draw freehand directly on the iris image – to circle a region of interest, mark a specific lacuna, trace the ANW ring position, or add any visual note that should be preserved with the image.

****Controls****

Control	Action
----- -----	
Annotate chip	Enter / exit annotation mode
Draw on image	Freehand drawing with a cyan stylus line
Undo button	Remove the last drawn stroke
Clear button	Remove all annotation strokes
Save PNG button	Export the annotated iris image as a PNG file

****Saving the annotated image****

Tap **Save PNG** to write a flat composite of the iris photo and all drawn strokes to the Windows Documents folder (or the app's documents directory on mobile). The file is named:

Annotated_<PatientName>_<YYYY-MM-DD>.png

> **Note:** Annotation strokes are session-local – they are not persisted in the database and are cleared when you leave the results screen. Save the PNG before navigating away if you want to retain the annotations.

3.10.5 Side-by-Side Eye Comparison

What it does

The Visual Compare dialog displays the OD (right) and OS (left) iris images side by side in synchronized, zoomable panels with the bilateral analysis metrics shown beneath each image. It is the fastest way to visually assess bilateral symmetry, asymmetric pigmentation, and differences in ANW position between the two eyes.

Opening the dialog

Tap the **Visual Compare** button on the analysis results screen (bottom button row).

Panel controls

| Control | Action |

|-----|-----|

| **Pinch-to-zoom / scroll wheel** | Zoom the panel independently, or both panels together if Sync Pan is active |

| **Drag** | Pan the image within the panel |

| **Mirror OD** toggle | Flip the right eye image horizontally so both irides are oriented with the nasal side facing inward – the standard bilateral comparison orientation used in clinical iridology |

| **Sync Pan** toggle | When enabled, pan and zoom gestures on either panel are mirrored to the other, allowing simultaneous navigation of both images at the same magnification and position |

****Bilateral metrics panel****

Below the two image panels, a metrics comparison card shows the following values side-by-side for OD and OS:

Metric	Display
PI Ratio	Percentage + interpreted label
Ellipseness	Percentage
Decentration	Percentage + direction
ANW Ratio	Percentage + Spastic / Normal / Atonic label
Hybrid Confidence	Percentage + A/B/C/D grade
Anisocoria (bilateral)	Absolute difference percentage + severity label

****Mirror convention****

The ****Mirror OD**** toggle is on by default. In standard iridology clinical practice, the right iris is viewed with the nasal side on the left (the anatomically correct perspective when the practitioner faces the patient). Mirroring OD reverses this so the two irides present with their nasal sides facing each other – the standard convention used in atlases and bilateral comparison charts.

3.10.6 Serial Scan Timeline

****What it does****

The Serial Scan Timeline is a longitudinal trend chart that plots up to six OD/OS metric series across all scans on file for the current patient, ordered chronologically. It provides a visual picture of how key iris and pupil measurements have changed between appointments.

****Opening the timeline****

From the Scan History screen (``Ctrl + H``), tap the ****timeline icon**** on any scan record. The dialog opens pre-filtered to that patient by name.

****Available metric series****

Series	Description
OD PI%	Right eye pupil-iris ratio over time
OS PI%	Left eye pupil-iris ratio over time
OD Ellip%	Right eye ellipseness (pupil circularity)
OS Ellip%	Left eye ellipseness
OD Conf%	Right eye hybrid confidence score
OS Conf%	Left eye hybrid confidence score

Each series can be independently toggled on or off using the chip controls at the top of the dialog. At least one series must remain enabled.

****Chart interactions****

Interaction	Action
Tap a data point	Shows the exact value and scan date as a tooltip
Horizontal scroll	Navigate left/right along the time axis when many scans are present
Toggle chips	Show or hide individual OD/OS series

****Trend interpretation logic****

The timeline uses a simple linear regression line plotted over each series to indicate the direction of change. The regression is purely descriptive – it does not apply clinical thresholds or generate alerts.

What to look for	Clinical significance
----- -----	
Rising PI% trend	Progressive pupil dilation over time; may indicate autonomic shift or age-related miosis reversal
Falling confidence trend	Image quality declining across sessions; review capture technique
Converging OD/OS PI%	Anisocoria resolving – bilateral symmetry improving
Diverging OD/OS ellipseness	One pupil becoming more irregular over the monitoring period

> ****Minimum data requirement:**** At least 2 scans for the same patient (matched by name) are required to display a timeline. A minimum of 3 scans is recommended for the regression line to be meaningful.

> ****Name matching:**** Patient records are matched by exact patient name (case-insensitive). Ensure consistent name spelling across sessions to keep all scans grouped correctly in the timeline.

3.10.7 Gabor Filter Texture Analysis

****What it does****

The Gabor chip convolves the iris image with a bank of ****2-D Gabor filters**** – sinusoidal plane waves modulated by a Gaussian envelope – tuned to multiple spatial frequencies and orientations. The magnitude response at each pixel records how strongly that pixel resembles an oriented stripe at each scale. Summing across orientations produces an ****energy map**** in which fibres, striae, radial sulci, and topi edges appear as bright ridges against a dark stroma background.

Gabor filtering is the canonical texture operator in iris image analysis: it underlies Daugman's original iris-code algorithm and remains the reference tool for fibre-density and fibre-orientation quantification.

****Filter bank parameters****

The default bank is configurable in Settings (§8.6). Factory defaults:

Parameter	Default	Notes
Number of scales	4	Spatial frequencies: 0.08, 0.16, 0.32, 0.64 cycles/pixel
Number of orientations	8	0°, 22.5°, 45°, 67.5°, 90°, 112.5°, 135°, 157.5°
Gaussian envelope σ	$2.5 \times \lambda$	Envelope proportional to wavelength
Aspect ratio γ	0.5	Ratio of minor to major Gaussian axis
Phase offset ψ	0° (even) and 90° (odd)	Magnitude computed as $\sqrt{\text{even}^2 + \text{odd}^2}$

****How to use****

Tap the ****Gabor**** chip. The iris image is replaced by the Gabor energy map rendered with a cool-to-hot gradient. Four small orientation swatches appear under the image showing the dominant response for each of the four cardinal axes (horizontal, vertical, and the two diagonals).

A ****Scale slider**** (1-4) under the image lets you inspect each spatial frequency independently – scale 1 emphasises fine fibre detail, scale 4 emphasises coarse structural bands such as the ciliary zone and the collarette.

****Quantitative readouts****

Readout	Meaning	Typical ranges
Fibre Density	Mean energy across the ciliary zone	Lymphatic 0.25-0.45 · Haematogenic 0.10-0.25
Radial Dominance	Ratio of radial-orientation energy to tangential-orientation energy	> 1.3 = strongly radial (classic lymphatic); < 0.9 = disorganised stroma
Fibre Uniformity	Inverse of energy standard deviation	Higher = more regular (tight/silk-like); lower = irregular/honeycomb

****Clinical applications****

- ****Constitutional typing**** – Fibre Density and Radial Dominance provide an objective backup to the subjective "tight vs. loose fibre" call in the Lymphatic group.

- ****Honeycomb pattern identification**** – Low Uniformity with low Radial Dominance is characteristic of Mesenchymal Pathological constitution.

- ****Stroma transparency assessment**** – A low-energy region in the ciliary zone indicates diminished stroma density, consistent with lacuna or crypt presence even below the detection threshold of §3.11.3.

- ****Teaching reference**** – The orientation swatches make the directional structure of the stroma visible to students who cannot yet see it in the raw image.

> ****Note:**** Gabor energy reflects oriented intensity gradient, not biological fibre presence per se. Bright pigment edges, scurf rim margins, and specular reflections all generate strong Gabor responses. Use §3.11.5 to suppress specular reflections before reading the energy map quantitatively.

3.10.8 Local Binary Pattern (LBP) Stroma Classifier

****What it does****

The LBP chip computes a ****uniform rotation-invariant Local Binary Pattern**** descriptor over the iris stroma and displays both a color-coded texture map and a histogram of the LBP pattern distribution. LBP is a simple but remarkably effective texture operator: each pixel is compared with its 8 neighbors on a circle of radius R , and the thresholded pattern is encoded as a compact integer code. Uniform rotation-invariant LBP (the $LBP_{8,1}^{riu2}$ variant) collapses all rotations of the same pattern into a single bin, making the descriptor invariant to the rotational orientation of the iris at capture time.

****How to use****

Tap the ****LBP**** chip. The iris image is replaced by a texture-type color map using the following legend:

Pattern class	Color	Physical meaning
Flat (uniform neighborhood)	Dark blue	Pigment field, solid tophi surface
Edge	Cyan	Fiber edge, lacuna boundary, collarette rim
Corner	Green	Fiber intersection, crypt corner
Line end	Yellow	Fiber terminus
Spot	Orange	Small lacuna, pigment spot
Non-uniform / mixed	Red	High-entropy region (disorganized texture)

Below the image, a ****LBP histogram**** bar chart shows the frequency of each pattern class across the iris. A secondary ****OD/OS histogram comparison**** appears when both eyes have been computed, letting you visually compare the texture signature of the two irides.

****Derived indices****

Index	Formula	Interpretation
Texture Entropy	$-\sum p_i \log p_i$ over LBP bins	Higher = more disorganized stroma; lower = more uniform texture
Flat-Pattern Ratio	Flat bin / total	Higher in Haematogenic; lower in Neurogenic Sensitive
Edge-Pattern Ratio	Edge bin / total	Higher in tight-fibred Lymphatic; a proxy for fiber density
OD/OS Texture Similarity	Histogram intersection	0-100%; > 85% suggests bilateral symmetric stroma

****Clinical applications****

- ****Constitutional subtyping**** – The LBP histogram shape is diagnostic for the broad constitutional groups; the Texture Entropy and Flat-Pattern Ratio together distinguish Lymphatic (low entropy, low flat ratio) from Haematogenic (moderate entropy, high flat ratio) from Biliary/Mixed (high entropy, variable).

- ****Bilateral symmetry**** – OD/OS Texture Similarity provides a single-number score for structural bilateralism; a markedly low value may indicate lateralized constitutional expression or lateralized acquired change.

- ****Longitudinal monitoring**** – Texture Entropy is added as an optional series to the Serial Scan Timeline (§3.10.6) so that stroma change over time can be tracked as a single quantitative trend.

> ****Tip:**** Run CLAHE (§3.10.1) before activating LBP for better separation of edge patterns on dark haematogenic irides. The edge and corner classes become much cleaner after local contrast equalization.

> ****Relationship to Gabor:**** Gabor and LBP are complementary. Gabor is directional and multi-scale; LBP is rotation-invariant and scale-specific. A practitioner who wants a full texture fingerprint should run both and read them side-by-side.

3.10.2E Iris 3D Relief Viewer – Enhanced Edition

Version 6.1+ significantly extends the existing 3D Relief viewer (§3.10.2). All controls from the original viewer remain unchanged; the additions listed below appear as a new ****Tools**** side panel that slides in from the right edge of the viewer dialog.

****Surface rendering****

| Control | Options | Effect |

|-----|-----|-----|

| ****Shading mode**** | Smooth · Flat · Wireframe · Points | Smooth is the existing default; Flat emphasizes individual triangle facets; Wireframe shows mesh structure only; Points displays the height-map as a point cloud |

| ****Mesh density**** | Low (64²) · Medium (128²) · High (256²) · Ultra (512²) | Controls the triangle count of the relief mesh. Ultra produces microscopic detail but is only recommended on desktop |

| ****Projection**** | Perspective · Orthographic | Orthographic projection eliminates foreshortening and is preferred for measuring relative heights between two features |

****Color and texture****

| Control | Options | Effect |

|-----|-----|-----|

| ****Palette**** | Photo-texture · Thermal · Viridis · Terrain · Greyscale · Depth-tinted · Pigment-density | Photo-texture is the existing default. New palettes map height to color instead of using the original photo, making relief structure easier to read |

| ****Texture blend**** | 0 - 100% | Mixes the selected palette with the photo texture; useful for seeing both pigment and relief simultaneously |

| ****Overlay**** | None · Zone polar grid · Collarette ring · Clock markers | Draws overlays directly on the 3D surface. Zone polar grid is the same overlay as the 2D results screen, projected onto the relief |

****Lighting****

Control	Range	Effect
****Light azimuth****	0° - 360°	Horizontal angle of the directional light - "rake lighting" from a low angle dramatically reveals subtle relief that is invisible at high angles
****Light elevation****	0° - 90°	Vertical angle of the directional light
****Ambient level****	0 - 100%	Global fill light - lower values deepen shadows for high-contrast relief
****Preset: Rake NE / NW / SE / SW****	-	One-tap preset angles for standard iridology relief inspection

****Camera presets****

Preset	Camera position
****Top-Down****	Direct overhead (90° elevation, 0° tilt) - equivalent to the 2D photo
****Landscape****	~56° tilt, 0° rotation - the existing default
****Side Profile****	0° elevation - pure side view of the relief, for measuring collarette ridge height
****3/4 View****	45° elevation, 30° rotation - textbook presentation angle
****Orbit Animation****	Rotates 360° around the Y-axis at 10° per second

Cross-section slicer

Slice type	Description
Radial slice	Cut from the pupil center outward along a user-selected clock angle (0°-360°). Reveals the relief profile across the collarette, ciliary zone, and periphery of a single zone
Meridional slice	Horizontal or vertical cut across the full iris. Useful for bilateral profile comparison
Freeform slice	Drag a line across the top-down view to define an arbitrary slice path

The slice profile view shows:

- Height (normalized 0-1) on the Y axis
- Distance along the slice on the X axis
- Colored markers at the pupil edge, collarette position, and iris rim
- A reference zero line for visual comparison

Differential relief

A **High-pass filter** slider subtracts a Gaussian-blurred copy of the height map from the original. Low values of the slider isolate fine-scale features – crypts, small lacunae, individual fibers – from the broad global curvature of the iris. This is particularly effective for isolating tophi and small lacunae that are visually dominated by the large-scale variation in stroma density.

Stereo anaglyph mode

Toggle **Anaglyph (Red/Cyan)** to render the 3D view as a red/cyan stereo pair. With standard red/cyan anaglyph glasses, the relief becomes convincingly three-dimensional in a way that improves depth perception of crypts and lacunae beyond what a rotating monocular view can achieve.

****Bilateral dual-pane 3D****

A ****Bilateral View**** button opens the 3D viewer in a split-pane layout with OD on the left and OS on the right. All controls (lighting, slicer, palette, camera) are synchronized between the two panes by default, with a ****Sync**** toggle to decouple them if independent inspection is required.

****Export formats****

| Export | Produces |

|-----|-----|

| ****PNG snapshot**** | Current 3D view as a 2048 × 1536 px image |

| ****Turntable MP4**** | A 6-second 360° rotation animation at 30 fps, H.264-encoded |

| ****Turntable GIF**** | Same as MP4 but as a 10-frame looping GIF (smaller file, lower quality) |

| ****STL mesh**** | 3D-printable mesh of the relief surface; can be loaded into any 3D-printing slicer |

| ****OBJ + texture**** | Textured mesh for import into Blender / ZBrush / Three.js for teaching visualisations |

> ****Note:**** Height in the 3D viewer continues to reflect luminance, not anatomical depth (see §3.10.2). The new palettes and lighting modes make subtle relief more perceptible, but they do not alter this fundamental caveat. Dense pigment regions may still appear artificially elevated. Cross-sectional measurements are therefore ****relative comparisons****, not absolute anatomical heights.

3.11 Advanced Iris Research Toolkit

The research toolkit is a new **Research** tab accessible from the bottom button row on the Analysis Results screen, positioned after the Visual Compare button. It collects tools that are more specialised than the standard chip-bar overlays and that benefit from a dedicated full-screen workspace.

The tab opens as a full-screen dialog with a left-edge vertical toolbar listing each tool. Selecting a tool activates it in the main pane. All tools are computed on demand and cached per eye for the session.

> **Intended audience:** The Research toolkit is aimed at practitioners conducting clinical research, teaching iridology at a university or institute level, or publishing comparative case studies. Routine clinical use of PupilMetrics does not require engagement with any of these tools.

3.11.1 Iris Rubber-Sheet Unwrapping (Daugman Normalisation)

(3.11 image above)

What it does

The rubber-sheet transform converts the doughnut-shaped iris region – bounded by the pupil inside and the iris rim outside – into a rectangular strip by mapping (radius, angle) polar coordinates into (x, y) Cartesian coordinates.

The unwrapped iris is the canonical form used in virtually all published iris-image research. Every zone, every fibre, every crypt becomes a vertical strip or a localised patch in a flat image that is easy to inspect, measure, and compare side-by-side across sessions.

****Output****

A 512 × 64 pixel rectangular image in which:

- The ****X axis**** represents angular position (0° at 3 o'clock, 90° at 12 o'clock, 180° at 9 o'clock, 270° at 6 o'clock)
- The ****Y axis**** represents normalised radius (0 = pupil edge at the top of the strip; 1 = iris rim at the bottom)
- Colour and pigment are preserved from the original image

****Overlays****

| Overlay | Displays |

|-----|-----|

| Clock scale | Clock-hour markers along the top edge (1-12) |

| Zone bands | Vertical shaded bands matching the eight iridology zones |

| Collarette line | Horizontal line at the detected collarette radius |

| Zone finding markers | Dots at the (angle, radius) of each FLAT / PROT / ANW finding |

****Clinical applications****

- ****Full-iris inspection at a glance**** – No rotation required to see the entire circumference.

- ****Sector comparison**** – OD and OS unwrapped strips can be placed on top of each other (after mirroring OS) to compare corresponding sectors directly.

- ****Publication**** – The unwrapped representation is the standard figure in iris-research papers; PupilMetrics can now export it directly.

- ****Teaching**** – Students see the full zone ring laid out linearly instead of needing to rotate around a disc.

3.11.2 Radial Fiber Orientation Map

What it does

Building on the Gabor filter bank from §3.10.7, the orientation map computes the **dominant Gabor orientation** at each pixel of the unwrapped iris and renders it as a color-wheel-encoded image. Each orientation (0° to 180°) is mapped to a hue; the saturation of the color encodes how strongly that orientation dominates over the others.

Interpretation

Color pattern	Stroma meaning
-----	-----
Uniform vertical (magenta in the default wheel) in the unwrapped strip	Well-organized radial fibers – classic Neurogenic Robust pattern
Horizontal (cyan) stripes	Concentric structures – contraction furrows, rings
Swirled / mottled	Disorganized stroma – common in Mesenchymal Pathological
Low-saturation grey zones	No dominant orientation – typical of dense pigment fields

Overlays

- **Orientation histogram** – Circular histogram showing global fibre orientation distribution for the entire iris
- **Zone-wise bar** – Small per-zone orientation dominance bars under each zone band
- **Rose plot** – Classical angular histogram on the 2D polar iris view

3.11.3 Crypt & Lacuna Auto-Detection

What it does

The crypt detector identifies dark depressions in the iris stroma using a three-stage pipeline:

- Pre-processing** – Specular inpainting (§3.11.5) and CLAHE normalisation.
- Blob detection** – A Difference-of-Gaussians (DoG) filter flags local dark minima at multiple scales.
- Shape validation** – Each candidate is fit to an ellipse; aspect ratio, solidity, and area are checked against constitutional ranges. Edge artefacts (corneal reflections, eyelash shadows) are rejected.

Each detection is drawn on the iris image as a numbered outline in cyan. The detail panel lists each crypt with its measured properties.

Detected properties (per crypt)

Property	Unit	Notes
Diameter	mm	Calibrated from the measured iris diameter in §3.3
Depth (relative)	0 - 1	Darkness of crypt interior vs. surrounding stroma
Shape class	Leaf · Round · Honeycomb · Torpedo · Defect-sign	Based on aspect ratio and solidity
Zone	Zone name	Derived from angular position
Radius band	Pupillary · Nutritive · Ciliary · Peripheral	Based on normalised radial position

****Summary output****

Readout	Meaning
****Crypt Count (OD/OS)****	Total detected per eye
****Shape Distribution****	Pie chart of shape classes
****Zone Distribution****	Bar chart of count per zone
****Symmetry Score****	OD/OS zone histogram intersection, 0-100%

****Clinical applications****

- ****Constitutional typing**** – A high honeycomb-pattern count is a marker for Mesenchymal Pathological; a leaf/petal distribution around the collarette is the signature of Glandular Pathological.

- ****Structured reporting**** – The detected crypt list is available as a new optional section in the PDF report (§4.3) and exported in the JSON data (§4.5).

- ****Longitudinal tracking**** – Crypt counts per zone are added to the Serial Scan Timeline (§3.10.6) for patients with lacunae-dominant constitutions.

> ****Note:**** Automatic detection is intended as a clinical aid, not a replacement for trained visual assessment. Small crypts below the 0.3 mm calibrated size threshold are deliberately not reported.

Borderline detections carry a confidence value and can be filtered in the detail panel.

3.11.4 Contraction Furrow (Nerve Ring) Detection

****What it does****

Contraction furrows – sometimes called ****nerve rings**** or ****cramp rings**** – are concentric circular grooves in the ciliary zone of the iris. In classical iridology they are associated with nervous-system irritability and chronic neuromuscular tension (see §6.2, Vegetative-Spastic constitution).

The detector scans the unwrapped iris strip (§3.11.1) for horizontal dark bands and reports each as a ring with measured properties.

****Output****

Column	Description
Ring ID	Sequential (Ring 1 = innermost)
Normalised radius	0 - 1, pupil → rim
Depth	Darkness contrast vs. neighbouring stroma
Completeness	% of the circumference the ring extends through
Clock-hour span	Start-end clock positions

****Clinical applications****

- Objective confirmation of the cramp-ring sign used in Vegetative-Spastic constitutional typing.
- Longitudinal monitoring of chronic stress or postural tension – progressive ring deepening or new ring appearance is a research-observational marker.

3.11.5 Specular Reflection Inpainting

****What it does****

Corneal reflections of light sources – the iriscopes LED ring, overhead lights, ceiling fixtures – produce bright specular spots that overlap the iris image. These spots contaminate CLAHE, Gabor, LBP, heatmap, and 3D-relief readings because they introduce non-biological high-luminance outliers.

The inpainting tool detects specular regions using a combined brightness + colour-saturation threshold, then reconstructs the underlying iris texture using the Telea fast marching inpainting algorithm seeded from the surrounding pixels.

Output

| View | Shows |

|-----|-----|

| **Original** | The raw iris image with a red transparent overlay marking detected specular regions |

| **Inpainted** | The same image with specular regions reconstructed from their neighbourhood |

Propagation

A **"Use inpainted image in overlays"** toggle in Settings (§8.6), off by default, applies the inpainted image upstream of all other overlay tools (CLAHE, Heatmap, Gabor, LBP, 3D Relief). When enabled, these overlays operate on the reconstructed image, producing cleaner texture metrics at the cost of approximately 30% additional per-session compute.

> **Important:** Inpainting does **not** change the core analysis pipeline, the pupil/iris boundary detection, or the stored scan record. It affects visualisation only.

3.11.6 Heterochromia Sector Mapping

What it does

The heterochromia mapper performs **k-means colour clustering** in the LAB colour space across the unwrapped iris and identifies regions of the iris whose dominant colour differs significantly from the overall iris colour centroid. The output highlights sectoral colour asymmetries – the characteristic sign of **sectoral heterochromia** – and quantifies the extent of each deviating sector.

****Output****

```
| Readout | Meaning |
|-----|-----|
| **Dominant colour (LAB)** | Reference colour for the iris as a whole |
| **Sector count** | Number of detected heterochromic sectors |
| **Per-sector detail** | Clock-hour range · angular span (°) · ΔE (perceptual colour distance) · Zone assignments |
| **Bilateral mismatch** | Central heterochromia count (OD vs OS) flag |
```

The results are drawn back on the 2D iris image as coloured outlines around each heterochromic sector, each labelled with its ΔE value. A secondary unwrapped view shows the heterochromia as a banded map across the full iris circumference.

****Clinical applications****

- ****Biliary/Mixed constitutional typing**** – Central heterochromia is a defining feature of several Biliary subtypes (§6.2).
- ****Localised liver-zone pigment detection**** – The 7–9 o'clock sector in OD is a classic liver-zone localisation; heterochromia mapping quantifies its extent and ΔE objectively.
- ****Congenital vs. acquired**** – Patients with iris sectoral asymmetry from early life can be distinguished from acquired pigment changes by reviewing historical images via §3.11.7.

3.11.7 Bilateral Structural Similarity Index (SSIM-OD/OS)

****What it does****

SSIM (Structural Similarity Index) is a perceptual image-similarity measure that reports how closely two images match in terms of luminance, contrast, and structure. PupilMetrics uses SSIM to quantify bilateral iris symmetry: after unwrapping both eyes (§3.11.1) and mirroring OS to match OD orientation, a windowed SSIM map is computed over the aligned pair.

****Output****

Readout	Meaning
****Global SSIM score****	0 - 1; > 0.85 = strongly symmetric · 0.70 - 0.85 = moderate · < 0.70 = asymmetric
****Per-zone SSIM****	Eight SSIM values, one per zone, as a radial bar chart
****Difference map****	The pixel-wise SSIM map rendered as a color image (red = low similarity, green = high)

****Clinical applications****

- ****Single-number bilateral symmetry**** – Practitioners who want one summary number for OD/OS similarity can use the Global SSIM score as a research-level complement to the visual side-by-side comparison.
- ****Zone-specific asymmetry**** – A low SSIM in a single zone, with all others high, flags a lateralized finding at that zone which may not be individually caught by the FLAT/PROT/ANW thresholds.
- ****Session consistency**** – Running SSIM between two captures of the same eye (from consecutive sessions) gives an objective image-quality-and-registration score; declining SSIM across a patient's scan history indicates that capture technique or device alignment is drifting.

3.11.8 Frangi Vesselness – Fibre Ridge Enhancement

****What it does****

The ****Frangi vesselness filter****, originally developed for retinal vessel segmentation, computes an eigenvalue analysis of the image Hessian at multiple scales to produce a vesselness probability at each pixel. In iris imaging, the same filter enhances ****radial fiber structures**** and ****transversal fibers**** against the stromal background producing a clean, high-contrast fiber map free of the directional bias of Gabor filtering.

****Output****

A greyscale vesselness map in which bright ridges mark detected fibres. The image is overlaid on the original iris using a user-controlled opacity slider.

****Derived metrics****

Metric	Meaning
-----	-----
Fiber coverage	Percent of ciliary-zone pixels above the vesselness threshold
Mean fibre thickness	Average width of detected ridges, in mm
Transversal count	Number of transversal fibers (fibers oriented non-radially)

****Clinical applications****

- Quantification of fiber density in low-contrast dark irides where visual assessment is difficult.
- Transversal fiber counting – transversals are a specific constitutional marker (Neurogenic Robust) and their automatic count provides an objective backup to visual assessment.

3.11.9 GLCM Haralick Texture Panel

****What it does****

The GLCM (Grey-Level Co-occurrence Matrix) panel computes the classical Haralick texture features over a per-zone basis. GLCM quantifies how often pairs of pixel values occur at a fixed spatial offset, and Haralick's derived features summarize this matrix into interpretable numbers.

Features reported (per zone)

Feature	Meaning
Contrast	Local intensity variation – high in fibrous regions
Homogeneity	Similarity of neighbouring pixel values – high in pigment fields
Energy	Uniformity – high for regular patterns, low for random
Entropy	Disorder – high for disorganised textures
Correlation	Linear predictability between neighbours – high for organised fibre runs

An eight-row table (one row per zone) shows the five Haralick features, colour-coded against a reference range. A radar chart at the top visualises the five features as a five-axis profile.

Clinical applications

- Haralick features are the most widely published quantitative texture descriptors in the medical image-analysis literature; including them means PupilMetrics output is directly comparable with external research datasets.
- Combined with Gabor + LBP, GLCM gives a complete texture-characterisation trio that covers the full space of stroma variation.

3.11.10 Iris Signature & Session Verification

What it does

An **iris signature** is a compact biometric fingerprint derived from the Gabor-phase code of the unwrapped iris (the Daugman iris code), stored locally alongside the scan record. The signature is used for one purpose only: to verify that two scans in the local Scan History correspond to the **same biological iris** – preventing accidental mis-association when a patient name is mis-spelled or when two patients share a name.

****What is stored****

A 256-byte phase code plus a 256-byte mask per eye. The code is not human-readable. The signature contains ****no pigment, texture, or photographic information**** – it is strictly a binary code used for matching.

****How it works****

When the Serial Scan Timeline (§3.10.6) is opened for a patient, each scan in the timeline is compared to the most recent scan using Hamming distance. Matching scans are grouped under a single shared identity; scans with a Hamming distance above 0.32 (the Daugman threshold) are flagged with an amber ****"Identity mismatch"**** warning icon so the practitioner can investigate.

****Privacy****

- All iris signatures are stored ****locally on the device only**** (same policy as §9.5).
- Signatures are ****never transmitted****, never sent to CNRI servers, and never exported in any report.
- Signatures can be purged in one action via a ****"Clear all iris signatures"**** button in Settings. Deleting a scan record deletes its associated signature.
- The signature cannot be inverted to reconstruct an iris image or photograph.

> ****Important:**** This feature is for ****internal record-continuity verification only****. It is not a biometric identification system, is not connected to any external database, and must not be used for identity verification, access control, or any security-related purpose.

3.11.11 Multi-Frame Fusion & Super-Resolution Capture

What it does

Rather than capturing a single frame at the moment the quality gate passes, Multi-Frame Fusion captures a **burst of 8 frames** across approximately 0.5 seconds and fuses them through two complementary processes:

1. **Image alignment** – Sub-pixel registration of each frame to the highest-quality reference frame, using normalized cross-correlation over a pupil-and-collarette landmark set.
2. **Super-resolution reconstruction** – Weighted averaging at up to 2× the input resolution, producing a single output image with reduced sensor noise, suppressed specular reflections (majority-voted out across frames), and increased effective resolution.

When it is active

Multi-Frame Fusion is an optional capture mode enabled per-eye on the Camera Mode Selector (§2.2). It is available in Quality-Gated mode and in USB / Iriscope mode. It is not available in PLR video mode (§2.6).

Trade-offs

Factor	Single frame	Multi-frame fusion
Capture time	Instant	~0.5 s
Patient cooperation	Minimal	Stable fixation for 0.5 s
Noise	Sensor noise present	Noise reduced by $\sim\sqrt{8} \approx 2.8\times$
Specular reflection	Fixed pattern preserved	Reflections reduced (if they fall on different iris regions across frames)
Effective resolution	Native sensor	Up to 2× native
Analysis accuracy	Reference pipeline	Identical pipeline; higher input quality improves all texture and relief readouts

****Clinical applications****

- Dino-Lite images at higher effective resolution for publication-quality figures.
 - Cleaner input for Gabor / LBP / Frangi texture tools – texture metrics from a fused capture are substantially more stable between sessions.
 - Reduced specular-reflection contamination without inpainting.
- > ****Note:**** The fused image and its per-frame source frames are both retained in the scan record. The per-frame set can be inspected in the Research tab; the fused image is what feeds the standard analysis pipeline.

3.12 PLR Signal Analysis Enhancements

Version 6.1+ substantially extends the PLR video mode (§2.6) with a quantitative signal-analysis layer. The existing pupil-diameter time series is unchanged; the new features all operate on that series after capture.

3.12.1 Constriction Kinetics – Velocity, Amplitude, Latency

The constriction kinetics panel extracts the four canonical PLR parameters from the diameter trace:

Parameter	Symbol	Definition	Normal adult range
Latency	T_{L}	Time from stimulus onset to the first detectable diameter reduction	200 – 280 ms
Maximum constriction amplitude	ΔD_{max}	Difference between baseline diameter and minimum diameter during the response	1.0 – 2.5 mm
Maximum constriction velocity	V_{c}	Peak of the first derivative of the diameter trace	3 – 7 mm/s
Constriction duration	T_{c}	Time from onset to minimum diameter	700 – 1,000 ms

Each value is shown with its normal adult reference range and flagged if outside the range. The ranges are adjustable per age group using the age-norm table already implemented in §3.2.

3.12.2 Redilation Time (T75)

T75 is the time required for the pupil to re-dilate to 75% of its pre-stimulus baseline diameter after the constriction minimum. It is a widely used marker of parasympathetic-sympathetic balance in pupillometry research.

T75 value	Interpretation
< 1.2 s	Rapid redilation – sympathetic dominance
1.2 – 2.0 s	Normal range
> 2.0 s	Slowed redilation – parasympathetic dominance, fatigue, or pharmacological influence

3.12.3 Hippus – Spontaneous Oscillation Detection

Hippus is the normal physiological low-frequency oscillation of pupil diameter at rest (typically 0.1 – 1 Hz). Increased hippus amplitude is a research-observational marker of autonomic instability.

After the constriction trace settles into its steady-state baseline (starting ~3 seconds after the stimulus), PupilMetrics computes:

Metric	Meaning
Hippus amplitude	Peak-to-peak baseline oscillation amplitude, normalised to mean diameter
Hippus frequency	Dominant frequency in the 0.05 – 1.5 Hz band
Hippus irregularity	Coefficient of variation of successive peak intervals

3.12.4 Spectral (Fourier) Analysis of the PLR Trace

A **Spectrum** tab on the PLR results screen shows the power spectral density of the baseline diameter trace (Welch's method, 4-second windows, 50% overlap). The spectrum is drawn with shaded bands for the three physiological frequency ranges:

Band	Range	Physiological association
Very low frequency	0.04 - 0.15 Hz	Thermoregulation, humoral activity
Low frequency	0.15 - 0.4 Hz	Sympathetic modulation (pupillary analogue of heart-rate LF)
High frequency	0.4 - 1.5 Hz	Parasympathetic modulation (pupillary analogue of heart-rate HF)

The LF/HF ratio is displayed as a single research-observational autonomic-balance proxy.

> **Research-only caveat.** All PLR signal-analysis metrics are experimental. They are influenced by ambient light, fixation stability, blinks, screen flash consistency, and camera frame rate. Published normative ranges assume laboratory-grade pupillometers; mobile-camera values may show systematic offsets. Use only for longitudinal comparison within the same patient and same device.

4. Patient Management & Exports

4.1 Patient Information Form

Before each scan, PupilMetrics collects the following information:

Field	Required	Notes
Name	Yes	Free-text; stored verbatim in the scan record

Age	Yes	Integer years; used to select the age-normalisation group (Section 3.2)
Sex	Yes	Male / Female toggle
Main complaints	No	Free-text field for the practitioner's clinical notes; appears in all exported reports
Practice / Clinic name	No	Pre-filled from the last saved value; persists across sessions via SharedPreferences

Clinic name persistence

The clinic name is automatically saved each time you tap **Continue** on the patient information screen. The next time you open the form, the field is pre-populated with the stored value, so you only need to enter it once per installation. To clear it, delete the text and tap Continue.

Data scope

Patient records live entirely on the local device – no data is transmitted to external servers. On Windows the database is stored in the app's Application Support directory (typically `%APPDATA%\cnri\pupilmetrics\bexel_scans.db`). On Android and iOS it uses the platform's sandboxed storage location.

4.2 Scan History

Every completed analysis is automatically saved to a local SQLite database the moment the results screen finishes loading. No manual save action is needed.

Opening Scan History

Platform	How to open
Windows	`Ctrl + H` keyboard shortcut, or the Scan History button on the results screen
Android / iOS	Scan History button on the results screen

****What is stored per scan****

Field	Description
Patient name, sex, age	From the patient information form
Main complaints	Practitioner notes at time of capture
Scan date/time	UTC timestamp recorded at analysis completion
OD / OS image paths	File paths to the captured eye images (not the images themselves)
OD / OS result JSON	Full analysis result: PI ratio, ellipseness, decentration, ANW assessment, zone findings, confidence
Anisocoria JSON	Bilateral pupil size comparison result
Age-norm JSON	Age group, expected range, measured diameter, status

****Searching records****

The search bar in Scan History matches against both patient name and main complaints text. The search is live – results update as you type. All results are sorted most-recent first.

****Tabs****

- ****Iris Scans**** – all standard analysis records (both platforms)
- ****PLR Tests**** – pupillary light reflex video recordings (mobile only; this tab is hidden on Windows desktop because the PLR video mode requires a phone's flash)

****Serial Scan Timeline****

Tap the ****timeline icon**** on any iris scan record to open the Serial Scan Timeline for that patient. The timeline plots PI ratio, ellipseness, and confidence scores for OD and OS across all matching scans, in chronological order. See Section 3.10.6 for full details.

****Excel Export****

On Windows, an ****Excel**** toolbar button exports the complete scan history to a formatted ``.xlsx`` spreadsheet. See Section 4.8 for details.

****Deleting a record****

Swipe a record left (mobile) or use the delete button (desktop) to remove it from the database. The associated image files are not automatically deleted from disk.

4.3 PDF Report

The PDF report is the primary export format. It is generated on-device using the `pdf` package and saved to the device's Documents folder (or shared directly on mobile).

How to generate

On the analysis results screen, tap the **PDF** button (printer icon). A progress indicator appears while the document is assembled, then a confirmation snackbar is shown with the saved file path.

On mobile, an additional **Share** button sends the PDF directly to any app that accepts files (email, cloud storage, messaging apps).

Report contents (in order)

Section	Contents
Header	Report title, app version (v6.0.0), clinic name banner (if set)
Patient information	Name, sex, age, age group, main complaints
Eye images	OD and OS photos side-by-side (compressed to ≤ 2000 px wide at 85% JPEG quality)
Pupil size comparison	Bilateral anisocoria table: OD%, OS%, difference%, severity label
Capture distance metrics	OD/OS iris diameter in pixels, size match %, distance match status
Right eye analysis	Grade, PI ratio + label, ellipseness, circularity, decentration; zone findings (FLAT/PROT/ANW) with severity; pupil form; ANW parameters
Left eye analysis	Same structure as right eye
Research observations	Cross-eye pattern notes (bilateral ANW, decentration patterns, etc.)
Observer notes	Free-text notes entered in the zone overlay dialog (if any)

| Herbal recommendations | *(If herbal mode enabled and findings exist)* Green-header section: per-finding cards with OD/OS badge, organ, conditions, herb names and evidence reference count, disclaimer |

| Nutrition recommendations | *(If nutrition mode enabled and findings exist)* Orange-header section: key nutrients, color-coded food groups, first organ support note |

| Chiropractic correlations | *(If chiropractic mode enabled and findings exist)* Purple-header section: spinal segment, nerve roots, subluxation indicators, exercises, postural note |

| TCM correlations | *(If TCM mode enabled and findings exist)* Red-header section: organ, element, meridian clock, functions, first pattern with symptoms/formula, tonifying foods |

****Natural medicine sections are only included when:****

1. The corresponding therapy module is enabled in Settings.
2. The analysis found at least one applicable iris finding for that modality.

This keeps the PDF concise for practitioners who use only selected therapy systems.

****File name format****

PupilMetrics_<PatientName>_<YYYY-MM-DD_HH-mm>.pdf

Example: `PupilMetrics_John_Smith_2026-03-23_14-35.pdf`

4.4 Plain-Text Report (TXT)

A plain-text version of the full report can be generated from the results screen. It contains identical clinical content to the PDF but is formatted for easy pasting into EHR systems, email, or any text editor.

The TXT report includes:

- All metrics for both eyes (PI ratio, ellipseness, circularity, decentration, zone findings)
- The full ANW parameters section (diameter, perimeter, ratio, sector breakdown)
- Age-normalised comparison
- Anisocoria summary
- Research observations
- Observer notes (if entered)

The TXT report does **not** include photos or therapy recommendation sections.

4.5 JSON Data Export

The JSON export provides machine-readable access to the complete analysis result. It is intended for integration with external clinical software or research workflows.

Top-level keys

```
json
```

```
{
  "date": "ISO 8601 UTC timestamp",
  "practice": "clinic name (if set)",
  "person": { "name", "sex", "age", "mainComplaints" },
  "ageNorm": { "ageGroup", "expectedRange", "measuredMm", "status" },
  "anisocoria": { ... },
  "captureMetrics": { "odIrisDiameterPx", "osIrisDiameterPx",
    "sizeMatchPercent", "distanceMatchStatus" },
  "rightEye": { ... full EyeAnalysisResult + anwAssessmentFull ... },
  "leftEye": { ... full EyeAnalysisResult + anwAssessmentFull ... },
  "bilateralANW": { "odRatio", "osRatio", "ratioDifference",
    "odStatus", "osStatus", "hasFunctionalFrustration" },
  "observerNotes": "free text (if any)"
}
```

Each eye object contains the complete `EyeAnalysisResult` fields (pupil/iris radii, confidence, all zone findings, decentration, ellipse, ANW) plus a `anwAssessmentFull` block with sector-level detail.

4.6 Sharing & Filing

****Windows****

The PDF and TXT files are saved to the Windows Documents folder. After generation, the confirmation snackbar shows the full file path. Files can then be attached to emails, copied to a shared drive, or uploaded to a cloud EMR through standard Windows file management.

****Android / iOS****

After tapping ****Share**** (the share icon beside the PDF button), the system share sheet opens. You can send the PDF directly to:

- Email (Gmail, Outlook, etc.)
- Cloud storage (Google Drive, iCloud Drive, Dropbox)
- Messaging apps (WhatsApp, Telegram, etc.)
- Print (via AirPrint on iOS or a network printer on Android)

****Re-generating a PDF from history****

Open Scan History (`Ctrl + H` on Windows), tap a record, and the results screen reopens with all stored analysis data. The PDF button is fully functional from the history view, allowing you to regenerate or share the report at any time.

4.7 Native Windows Print

On Windows, PupilMetrics can send the analysis report directly to any installed printer via the Windows native print dialog.

****How to print****

On the analysis results screen, tap the ****Print**** button (bottom button row). The Windows native print dialog opens immediately. Select your printer, adjust paper size and orientation if required, then click ****Print****.

****What is printed****

The printout reproduces the on-screen analysis results in a print-optimised layout:

- Patient name, date, and clinic name in the header
- OD and OS iris images side by side
- All key metrics (PI ratio, ellipseness, decentration, ANW ratio, anisocoria, confidence grade)
- Zone findings (FLAT/PROT/ANW) with severity percentages and organ associations
- Research observations and observer notes (if entered)

The printout does ****not**** include natural medicine therapy panels (use the PDF export if you need those). Annotated iris overlays can be printed via ****Save PNG**** and then printed separately from the saved file.

****Printer requirements****

Any printer installed in Windows (USB, network, or virtual PDF printer) is supported. For best results, print at A4 or Letter size with at least 300 DPI resolution.

> ****Tip:**** To print a PDF-quality report with therapy panels, generate the PDF first (``$4.3``) and then print the PDF from your PDF viewer.

4.8 Excel Scan History Export

On Windows, the full scan history can be exported to a formatted Microsoft Excel workbook (`.xlsx`). This is useful for longitudinal research, practice record-keeping, or importing data into clinical analysis software.

How to export

From the Scan History screen (Ctrl + H), tap the **Excel** toolbar button. A progress indicator appears while the workbook is built. When complete, a confirmation snackbar shows the saved file path with an **Open** link that launches the file directly in Excel.

Save location

%USERPROFILE%\Documents\PupilMetrics_History_<YYYY-MM-DD>.xlsx

Workbook structure

The export uses Syncfusion XlsIO with styled formatting:

Column	Content
Date	Scan date/time (local)
Patient Name	As entered on the patient information form
Age	Patient age at time of scan
Sex	M / F
Main Complaints	Practitioner notes
OD PI%	Right eye pupil-iris ratio
OD Ellip%	Right eye ellipseness
OD Decentration%	Right eye decentration

OD ANW Ratio%	Right eye ANW/collarette ratio
OD Grade	Right eye hybrid confidence grade (A/B/C/D)
OD Confidence%	Right eye hybrid confidence score
OS PI	Left eye pupil-iris ratio
OS Ellip%	Left eye ellipseness
OS Decentration%	Left eye decentration
OS ANW Ratio%	Left eye ANW/collarette ratio
OS Grade	Left eye hybrid confidence grade
OS Confidence%	Left eye hybrid confidence score
Anisocoria%	Absolute OD-OS PI difference
Anisocoria Severity	None / Mild / Moderate / Severe

Formatting

- **Header row**: Dark teal background, white bold text, freeze pane applied so the header remains visible when scrolling
- **Data rows**: Alternating white and light-grey tint for readability
- **All columns**: Auto-width fitted to content

> **Note:** The Excel export includes all scan records currently in the database – it is not filtered by patient or date. To analyse a subset, use Excel's built-in filter function on the Patient Name or Date columns.

5. Natural Medicine Therapy Panels

The four therapy modules are **optional overlays** on top of the core iris analysis. Each panel takes the zone findings from the analysis pipeline (flattening, protrusions, and ANW shifts) and maps them to a specific natural medicine framework. They are educational and reference tools intended for licensed practitioners who are already trained in the corresponding modality.

> **Clinical disclaimer.** The therapy panels are educational references only. They do not constitute medical advice and must not be used as the sole basis for clinical decisions. The practitioner is solely responsible for the application of any recommendation.

5.1 Enabling the Therapy Modules

Each module is toggled independently in **Settings**. Disabled modules produce no panel and no PDF section.

Module	Setting key	Default
Herbal Recommendations	Herbal mode	Off
Nutrition Recommendations	Nutrition mode	Off
Chiropractic Correlations	Chiropractic mode	Off
TCM Correlations	TCM mode	Off

Toggle any module on, then run a scan. If the analysis finds qualifying iris zone findings, the corresponding panel appears as a tab (or section) on the results screen and is appended to the PDF report.

5.2 How Zone Findings Drive the Therapy Panels

All four engines share the same iris zone input pipeline:

Qualifying finding types

Finding type	Badge	Weighting in ranking
Flattening (lacuna / crypts)	FLAT	severity × 1.2 (highest priority)
Protrusion (raised sector)	PROT	severity × 1.0
ANW shift (ring displacement)	ANW	deviation × 0.8

Findings are ranked by their weighted score. Each engine caps the number of displayed cards:

- Herbal engine: up to **6 zone cards**
- Nutrition engine: up to **6 zone cards**
- Chiropractic engine: up to **5 zone cards**
- TCM engine: up to **5 zone cards**

If a zone maps to an organ that the database does not cover, that zone is silently skipped. No recommendation card is generated.

OD / OS labelling

Every card carries an eye badge (**OD** = right / **OS** = left) so the practitioner knows which eye produced the finding. The iris zone map is mirrored between eyes: for example, the 9-o'clock zone is the right lung (OD) and the left lung (OS); the 3-o'clock zone is the left heart/pericardium (OS) and the right back/pleura (OD).

5.3 Herbal Recommendations Panel

Data source

The herbal database (``assets/therapy/herbal_database.json``) is derived from a 5,722-page CNRI knowledge base. It is structured as:

condition name → list of herbs, each with a reference count.

The reference count reflects how many source documents cited that herb for that condition. Higher counts indicate broader cross-reference support.

How it works

1. The engine takes the organ keywords associated with the triggered iris zone.
2. It runs a case-insensitive prefix search across all condition names in the database.
3. Up to **4 matching conditions** per zone are returned, each with up to **6 herbs** ranked by reference count.
4. Zones are sorted so the highest-severity zone appears first.

****What the panel shows****

Each recommendation card displays:

- ****Eye badge**** (OD/OS) and ****finding badge**** (FLAT/PROT/ANW)
- ****Zone name**** and associated organ system
- ****Severity percentage**** from the iris analysis
- ****Matched conditions**** – up to 4 condition names relevant to that organ
- ****Herb list**** per condition – herb name + reference count shown as a chip; tapping a chip opens the source reference list
- ****Evidence note**** – total number of references for the top herb

****Disclaimer strip****

A disclaimer is shown at the bottom of every herbal card and is also printed in the PDF. It reminds practitioners that herb-drug interactions exist and that professional supervision is required.

****Languages:**** Panel UI labels, iris-zone organ names in card headers, and herb remedy names (Phase 1) are fully localised into all 15 supported app languages. The active app language is applied automatically.

5.4 Nutrition Recommendations Panel

****Data source****

The nutrition database (`assets/therapy/nutrition_database.json`) is structured around organ systems, with each organ entry containing:

- ****Key nutrients**** – vitamins, minerals, and cofactors known to support that organ
- ****Color-coded foods**** – foods grouped into 7 diet colors (Red, Orange, Yellow, Green, Blue/Purple, White, Brown)
- ****Supportive herbs**** – culinary and medicinal herbs cross-referenced to that organ
- ****Organ support notes**** – brief clinical rationale for the dietary approach

****The 7-Color Diet framework****

The color system is derived from the phytonutrient literature: each color group provides a different spectrum of antioxidants, flavonoids, and co-factors. The panel presents color groups as visual chips so practitioners can give patients an intuitive shopping guide.

Color group	Representative phytonutrients
Red	Lycopene, anthocyanins
Orange	Beta-carotene, hesperidin
Yellow	Lutein, zeaxanthin
Green	Chlorophyll, sulforaphane, folate
Blue/Purple	Resveratrol, anthocyanins
White	Quercetin, allicin (alliums)
Brown	Lignans, beta-glucans (whole grains)

****When an iris zone maps to multiple organs**** (e.g. the lower-basal zone maps to Kidney + Adrenal + Leg), the engine merges the nutrient, food, and herb lists from all matched organs and de-duplicates them. The `matchedOrgans` list on each card shows which organs contributed data.

****What the panel shows****

Each card displays:

- ****Zone and organ****, finding type badge, severity
- ****Key nutrients**** – listed in priority order
- ****Color-food grid**** – up to 4 foods per color group, displayed as coloured chips
- ****Supportive herbs**** – small herb chips distinct from the herbal recommendations module
- ****Organ support note**** – a one-sentence clinical rationale for the dietary focus

****Languages:**** All panel UI labels, iris-zone organ names in card headers, and diet colour category names are fully localised into all 15 supported app languages.

5.5 Chiropractic Correlations Panel

****Data source****

Spinal segment data is compiled directly into the app (no external asset file is loaded at runtime). The zone-to-segment mapping follows the ****pupillary-border iridology convention****:

```
| Iris clock position | Spinal region |
|-----|-----|
| 12 o'clock (upper-central) | Upper Cervical C1-C4 |
| 10-11 / 1-2 o'clock (upper) | Mid/Lower Cervical C4-C7 |
| 9 / 3 o'clock (middle) | Upper Thoracic T1-T6 |
| 7-8 / 4-5 o'clock (lower) | Lower Thoracic T7-T12 |
| 6 o'clock (lower-basal) | Lumbar / Sacral L1-S3 |
```

Both eyes map to the ****same spinal column**** – the spine is midline, so OD and OS findings at the same clock position point to the same vertebral level.

****What the panel shows****

Each spinal segment card displays:

```
| Section | Contents |
|-----|-----|
| **Segment label** | e.g. "Upper Cervical C1-C4" |
| **Vertebrae** | Individual vertebrae with common names (e.g. C1 Atlas, C2 Axis) |
| **Nerve roots** | Exiting nerve roots at that level |
| **Innervated structures** | Organs and tissues supplied by those nerves |
| **Subluxation indicators** | Classic symptoms associated with fixation at this level |
| **Affected muscles** | Muscles commonly involved in nerve compromise at this level |
| **Adjusting approach** | Standard chiropractic techniques applicable to the region |
```

| **Exercises** | Corrective exercises, stretches, and lifestyle recommendations |

| **Postural note** | Ergonomic or postural guidance specific to this spinal region |

Sources

Winsor (1921) sympathetic segmental disturbances study; Cleveland Chiropractic College nerve-organ chart; Palmer textbooks; Jensen and Angerer iridology references.

5.6 TCM Correlations Panel

Data source

TCM data is compiled into the app (no external file). Each iris zone × eye-side combination maps to a specific TCM organ system entry. The TCM map is eye-side-specific: for example, the middle-temporal zone is the **right lung** in OD and the **left heart / pericardium** in OS – which is the same distinction already present in the iridology iris zone map.

Five Elements framework

Each TCM organ belongs to one of the Five Elements (Wu Xing):

| Element | Color | Season | Climate | Taste | Emotion | Sense organ |

|-----|-----|-----|-----|-----|-----|-----|

| **Wood** | Green | Spring | Wind | Sour | Anger / Frustration | Eyes |

| **Fire** | Red | Summer | Heat | Bitter | Joy / Anxiety | Tongue |

| **Earth** | Yellow | Late Summer | Dampness | Sweet | Worry / Overthinking | Mouth |

| **Metal** | White/Grey | Autumn | Dryness | Pungent | Grief / Sadness | Nose |

| **Water** | Blue/Black | Winter | Cold | Salty | Fear / Will-power | Ears |

The element colour is used as the card accent throughout the panel.

****What the panel shows****

Each TCM card displays:

Section	Contents
****Organ pair****	Primary organ + paired organ (e.g. Liver ↔ Gallbladder)
****Element bar****	Element name, season, climate, emotion, taste, nature (Yin/Yang)
****Meridian clock****	Peak 2-hour energy window (e.g. Liver: 1-3 AM)
****Meridian functions****	Key physiological roles in TCM theory
****Governs****	Body tissues governed (e.g. Liver governs tendons, nails, and the eyes)
****Patterns****	Common TCM imbalance patterns; each pattern lists symptoms, classical herbal formulas, and key acupoints
****Acupoints****	Top acupressure/acupuncture points with brief descriptions
****Tonifying foods****	Foods that nourish this organ in TCM dietary therapy
****Foods to moderate****	Foods that may stress this organ when consumed in excess

****Imbalance patterns****

Each pattern card shows:

- Pattern name (e.g. "Liver Qi Stagnation", "Heart Blood Deficiency")
- Key symptoms in bullet form
- Classical formula names (e.g. *Xiao Yao San*, *Tian Wang Bu Xin Dan*)
- Primary acupoints (WHO standard point codes, e.g. LV3, HT7)

****Sources****

Maciocia (2005), Deadman & Al-Khafaji (2007), WHO acupoint standards (2008), Pitchford, Flaws, and compiled Jilin/Shanghai TCM texts.

5.7 Reading Therapy Panels Together

The four panels are designed to be **complementary, not redundant**. A practitioner might use:

- **Herbal panel** → identify specific botanical agents with the strongest cross-reference evidence for the affected organ system
- **Nutrition panel** → build a dietary protocol using the 7-color food guide for the same organ
- **Chiropractic panel** → identify the spinal level most likely to have neuro-functional involvement with that organ
- **TCM panel** → frame the clinical picture within Five Element theory, select meridian points, and recommend classical formulas

All four draw from the same iris zone findings, so the same flattening that generates an herbal recommendation also appears in the nutrition, chiropractic, and TCM panels – allowing the practitioner to build a cohesive multi-modality protocol from a single iris analysis session.

6. Constitutional Iridology

Constitutional iridology is the assessment of an individual's inherited iris structure to identify long-term physiological tendencies, organ predispositions, and constitutional health patterns. PupilMetrics implements Dr. Josef Deck's classification system, expanded and annotated by Dr. Bryan K. Marcia's CCVE manuscript.

> **Platform note:** The constitutional type selector is available on **Windows desktop only**. The constitutional panel and PDF section appear on all platforms when a type was selected before analysis.

6.1 Background & Theoretical Basis

Constitutional iridology originated with the German iridologist Dr. Josef Deck, whose work in the mid-20th century systematically grouped iris structural patterns into repeating constitutional categories. Unlike topographic iridology (which maps specific iris zones to specific organs), constitutional typing focuses on the **overall fiber texture, pigmentation pattern, and structural qualities** of the iris as a whole – providing a framework for understanding a patient's baseline reactivity, strengths, and long-term susceptibilities.

The system was further developed by Russian medical iridologist Professor Sergei Velhover and others in the European and Soviet iridology traditions. Dr. Bryan K. Marcia's CCVE manuscript (the knowledge basis for PupilMetrics's implementation) integrates Deck's original framework with German homeopathic research, linking each constitutional type to specific homeopathic remedy affinities documented in clinical practice.

Key principle: Constitutional type describes an inherited terrain – it indicates *inclinations and predispositions*, not current disease states. A constitutional pattern suggests what organ systems may require monitoring or support over the patient's lifetime, not what is acutely wrong today. Clinical correlation with symptoms, history, and other examination findings is always required.

6.2 The 34 Constitutional Types

PupilMetrics includes 34 constitutional types organized into six groups:

Group 1 – Lymphatic (8 types)

The Lymphatic constitution is the most common in light-eyed populations. The base iris is typically light blue-grey with well-defined, silk-like or wavy fibers. Subtypes are defined by the presence and character of tophi (whitish connective-tissue deposits), pigmentation, and fiber arrangement.

Type	Key Feature	Primary Tendencies
Pure Lymphatic	Sparse pigment, distinct radial fibers	Lymphatic congestion, allergies, upper-respiratory catarrh, rheumatic tendency
Neurogenic Sensitive *(Neurolymphatic)*	Thin, tight, "combed-hair" fibers	CNS sensitivity, migraines, autonomic dysfunction, nervous hypersensitivity
Neurogenic Robust	Thick radials on two levels, transversals	Good nerve vitality but serous membrane susceptibility; overstrain leads to nervous exhaustion
Lymphatic-Hypoplastic	Thickened collarette, crypts, cloudy pupillary zone	Impaired digestion/assimilation, gastric insufficiency, lowered resistance
Hydrogenoid-Hydrogenic	Rounded, well-defined white-to-off-white tophi	Strong allergic/exudative tendency, asthma, eczema, weather-related rheumatism
Hydrogenoid-Rheumatic	Tophi with string-like connections to lymph region	More pronounced rheumatic tendency than base Hydrogenic; dysbiosis
Classic Rheumatic	Transparent tophi and wisps; scurf rim	Exudative diathesis, streptococcal rheumatic group, joint pain, chronic allergies
Rheumatic-Uric Acidic	Enhanced plaques and wisps in stroma	Uric acid diathesis; urate stone tendency; liver/kidney uric acid metabolism disorder

Group 2 – Haematogenic (2 types)

The Haematogenic constitution is defined by a uniformly dark brown iris with velvet-like texture and heavy pigmentation. It is associated with blood and metabolic disorders.

Type	Key Feature	Primary Tendencies
Haematogenic I	Dense velvet-brown iris, sanded-wood light patches	Blood composition dyscrasia; metabolic disorders of liver and pancreas
Haematogenic II	Brown scleral pigmentation	endocrine signs Arteriosclerosis, gallstones, hemorrhoids, phlebitis, thyroid and endocrine disorders

Group 3 – Biliary / Mixed (9 types)

The Biliary/Mixed iris shows dispersed brown pigmentation overlying a lighter stroma – producing a light brown appearance with blue-green undertones. The liver, gallbladder, and biliary tract are the primary organ affiliations.

Type	Key Feature	Primary Tendencies
Classic Biliary *(Mixed Iris)*	Light brown iris; dense nutritive zone pigment	Liver/gallbladder congestion; digestive errors; constipation, flatulence, blood sugar instability
Ferrum Chromotosis	Golden-brown/red-brown pigments encircling collarette	Hepatic parenchyma damage; fat metabolism difficulty; fatigue; depression
Rheumatic-Uric Acidic-Dyscratic Gr.1	Central heterochromia; plaques/tophi; cramp rings in liver zone	Rheumatic illness; uric acid metabolism disorder; gastric secretion imbalance
Rheumatic-Uric Acidic-Dyscratic Gr.2	Strong pigmentation; scurf rim; dispersed liver pigments	Increased chronic inflammatory tendency (sinusitis, appendicitis, tonsillitis)
Rheumatic-Dyscratic-Hepatic	Distinct tophi/plaque pigmentation; liver-zone darkening	Chronic rheumatism combined with liver dysfunction; dysbiosis
Rheumatic-Uric Acidic-Dyscratic-Hepatic	Full-iris pigmentation; uric acid clouds; progressed plaques	Chronic rheumatism, uric acid complications, liver and biliary involvement
Rheumatic-Arthrotic	Mixed iris; brown/yellow tophi pigment; border pigments	Arthrotic chronic rheumatic illness; liver/kidney metabolic irregularity
Rheumatic-Arthrotic-Dyscratic	Stronger tophi/plaque pigmentation; uric acid granules	Degenerative joint disease; dyspepsia; gastric secretion disorders
Arthrotic-Dyscratic-Dysenzymatic	Haematogenic transition; rheumatic plaques; stomach-field outline	Liver, pancreas, GI disorders; raised uric acid, blood lipids, blood sugar

Group 4 – Pathological Constitutions (6 types)

Pathological constitutions represent inherited structural weakness patterns identifiable as lacunae, defect markings, or corneal signs, regardless of primary iris color.

| Type | Key Feature | Primary Tendencies |

|-----|-----|-----|

| ****Glandular Pathological**** | Petal-pattern lacunae around collarette; distended collarette | Endocrine/exocrine glandular weakness; diabetes predisposition; anxiety, depression |

| ****Immuno-Pathological**** | Grey/black substance-defect points; absent or broken frill | Poor immune resistance; frequent infections; poor physical endurance |

| ****Cardio-Pathological**** | Open defect marking at 3 o'clock (heart zone) on frill | Inborn left cardiac insufficiency risk; endocarditis/myocarditis susceptibility |

| ****Vegetative-Spastic**** *(Larvate Tetanic)* | Cramp rings (circular contraction furrows); radial folds | Elevated neuromuscular tension; spasms; migraines; anxiety; hypocalcemia |

| ****Mesenchymal Pathological**** *(Weak Connective Tissue)* | Large, numerous lacunae; honeycomb patterns; irregular collarette | Inherited connective tissue weakness; varicosities; prolapse; spinal subluxations; fractures |

| ****Lipaemic Pathological**** | Arcus senilis / cholesterol ring (corneal sign, not iris) | Raised blood lipids; premature arteriosclerosis; stroke risk; liver/fat metabolism disorder |

Group 5 – Syndromes (6 types)

Syndromes represent combined constitutional expressions involving specific organ pairings, visible as lacunae patterns in defined iris sectors.

| Type | Key Feature | Primary Tendencies |

|-----|-----|-----|

| ****Cardio-Renal**** | Lacunae in heart AND kidney fields (left iris); scurf rim | Left cardiac + renal insufficiency; edema; dyspnea; begins in middle age |

| **Cardio-Abdominal** | Large heart lacuna; colonic lacunae; distended collarette in splenic flexure | Colon congestion mechanically stressing heart; flatulence; cardiac dyspnea |

| **Pancreatic** | Lacunae in pancreatic sector and bronchial zone | Multi-glandular insufficiency; hereditary bronchial and pancreatic weakness; childhood infections |

| **Hepato-Gastric** | Liver pigment over liver zone; radial/transverse line from pylorus to liver zone | Liver/gallbladder disturbance; possible erosive ulcer; jaundice tendency |

| **Hepato-Lienal** | Dirty yellow ciliary pigment; dark spleen field (splenic triad) | Spleen enlargement; venous congestion; viral infections; pancreatic excretory dysfunction |

| **Hepato-Renal** | Green-brown-yellow "liver iris"; transversals in liver-kidney zones | Full range of liver and kidney disorders; poor food tolerance; hypotension |

Group 6 – Pre-Cancerous Constitutions (3 types)

Pre-cancerous constitutions describe inherited miasmatic terrains associated with chronic toxicosis, metabolic retention, and increased neoplasm risk. These require the greatest caution in clinical interpretation and must never be communicated to a patient without full clinical context.

Type	Key Feature	Primary Tendencies
Psoric	Loose ciliary zone with crypts; open/closed lacunae near collarette; unequal pupils	Immune system pathology; allergic diseases; skin eruptions; reduced drug tolerance
Sycotic	Dark pupillary zone; brighter ciliary zone from contraction furrows; scurf rim	Viral/bacterial immune sensitivity; endocrine disturbances; condyloma; arthritis
Carbon Nitrogen	Dark pupillary crypts; yellow-brown humoral zone; scurf rim; splenic triad	Carbonic/nitrogen waste accumulation; neoplasm tendency from retained toxicosis; arteriosclerosis

6.3 Selecting a Constitutional Type

Constitutional type selection is performed on the **"Both Eyes Captured"** screen, which appears after both left and right eye photos have been taken. At this point the practitioner has both eye images visible side by side – the appropriate moment for constitutional assessment, since Deck's system requires evaluation of both irides together.

To select a type (Windows desktop only):

1. Complete the right eye capture (Step 1 of 2).
2. Complete the left eye capture. The screen title changes to **"Both Eyes Captured"** when both images are present.
3. Scroll below the eye image pair. An amber-bordered panel labelled **"Constitutional Type (Optional)"** is visible.
4. Click the dropdown to open it. Types are organized by group with non-selectable group dividers.
5. Select the appropriate type. The type name is confirmed below the dropdown.
6. Leave the dropdown at **"None (not assessed)"** to omit the constitutional section entirely from the analysis and PDF.
7. Tap **Analyze Both Eyes** to proceed.

> **Session persistence:** The selected type is held in memory for the current session. If you navigate back to the Both-Eyes-Captured screen, the previously selected type is restored. The selection is cleared when a new scan session begins from the home screen.

Assessment approach: Constitutional typing requires experience and ideally evaluation of the iris under magnification (slit lamp or iridroscope). The practitioner should consider:

- **Iris base color** – blue-grey → Lymphatic group; dark brown → Haematogenic; light brown/mixed → Biliary/Mixed
- **Fiber density and texture** – tight/silk-like vs. loose/wavy vs. coarsely woven with lacunae
- **Tophi and plaques** – presence, definition, and color of connective-tissue deposits
- **Pigmentation pattern** – central heterochromia, scurf rim, liver-zone pigments, dispersed spots
- **Special structures** – cramp rings, heart-zone defect markings, arcus senilis/lipaemic ring

When the constitutional group is clear but the exact subtype is uncertain, selecting the base type (e.g., *Pure Lymphatic*, *Classic Biliary*, *Haematogenic I*) is preferable to guessing a complex subtype.

6.4 Constitutional Panel in Analysis Results

When a constitutional type has been selected, an amber-bordered **Constitutional Iridology** panel appears in the Analysis Results screen, positioned **after the bilateral comparison card and before the Natural Medicine Therapy panels**.

The panel contains three collapsible sections:

Section	Content	Default
Iris Description	Full description of the iris structural and pigmentation features that define this constitutional type	Expanded
Health Predispositions	Bulleted list of organ systems, disease tendencies, and physiological patterns associated with this constitution	Expanded
Homeopathic Remedies	Chip tags showing the German homeopathic remedies with constitutional affinity for this type, from Dr. Marcia's CCVE research	Collapsed

Tap any section header to expand or collapse it independently.

> **Relationship to zone findings:** The constitutional panel is independent of the automated iris zone analysis. Zone findings (flattening, protrusions, ANW shifts) reflect current or acquired changes; constitutional type reflects the inherited structural terrain. Both perspectives are complementary and intended to be read together.

6.5 Constitutional Section in the PDF Report

When a constitutional type is selected, the exported PDF includes a dedicated **Constitutional Iridology** section inserted between the bilateral ANW (collarette) assessment and the Natural Medicine therapy sections.

The PDF section uses a light, print-optimized layout:

Part	Appearance
Header bar	Warm cream background – constitution name in bold,
group badge in solid amber	
Iris Description	Light blue tint background, black body text
Health Predispositions	Light peach tint, dash-bulleted list in
black	
Homeopathic Remedies	Light green tint, remedy chips with dark
green text and border	
Footer	Grey italic – **"Based on Dr. Josef Deck's Constitutional
Iridology – for educational reference only."** |

If no constitutional type was selected, this section is omitted from the PDF entirely.

6.6 Clinical Guidance & Limitations

****Training required.**** Accurate constitutional typing requires formal training in iridology. Practitioners unfamiliar with constitutional iridology should complete dedicated training before using this feature clinically.

****Not a diagnosis.**** Constitutional patterns describe inherited tendencies, not diagnoses. A patient with a Cardio-Pathological constitution has an inherited structural predisposition – they do not necessarily have heart disease. Constitutional findings must always be interpreted alongside the patient's full history, symptoms, and conventional medical evaluation.

****Homeopathic remedies.**** The remedy affinities listed for each type reflect traditional German homeopathic-iridology correlations from the CCVE research base. They are provided for ****educational reference only****. Homeopathic prescribing is individualized and requires formal homeopathic training; the constitutional type alone does not constitute a prescription.

****Pre-cancerous constitutions.**** The Psoric, Sycotic, and Carbon Nitrogen types carry a "pre-cancerous" label in traditional constitutional iridology. This describes an inherited metabolic terrain, not a prediction or diagnosis of cancer. These findings must ****never**** be communicated as a cancer risk without full evaluation by a qualified oncologist. Practitioners in jurisdictions where such communication could constitute an unlicensed diagnostic statement must exercise particular caution.

****Windows-only selection.**** The constitutional dropdown is available only on Windows desktop. The constitutional panel and PDF section will appear on all platforms if a type was selected during a Windows session – but the type cannot be modified on mobile.

7. Exporting PDF Reports

7.1 What Affects the PDF Output

The PDF report is assembled at the moment you tap the export button. Several settings influence its final content:

Setting	Effect on PDF
Include images in PDF (on by default)	OD and OS photos are embedded side-by-side on page 1. Turning this off produces a smaller, text-only document
Practice / Clinic name	Appears in a teal banner below the report title on every page header
Language	The entire report – section headings, metric labels, status labels, finding descriptions – is generated in the currently active app language
Herbal / Nutrition / Chiropractic / TCM mode	Each enabled module adds a section at the end of the report, but only when at least one qualifying finding is present
Auto-save PDF (off by default)	When enabled, the PDF is saved automatically at the end of every analysis without requiring a manual tap

7.2 Report Language

The PDF is generated using the active interface language at the time of export. All localizable strings – including metric names, zone finding descriptions, ANW status labels, age group names, and therapy section headings – are pulled from the same localization tables used by the on-screen interface.

Supported languages: English, Spanish, Portuguese (Portugal), Portuguese (Brazil), French, German, Italian, Japanese, Korean, Chinese (Simplified), Arabic, Hindi, Polish, Russian, Turkish.

To export a report in a specific language, switch the app language in Settings before tapping the PDF button. You can switch back immediately after.

7.3 File Naming and Save Location

****File name format****

PupilMetrics_<PatientName>_<YYYY-MM-DD_HH-mm>.pdf

Spaces in the patient name are preserved. The timestamp is in local time.

****Save location****

| Platform | Default save path |

|-----|-----|

| ****Windows**** |

`%USERPROFILE%\Documents\PupilMetrics_<name>_<date>.pdf` |

| ****Android**** | App documents directory (accessible via Files app) |

| ****iOS**** | App documents directory; use Share to send to Files, iCloud, etc. |

****Auto-save****

When Auto-save PDF is enabled, the file is written silently immediately after analysis completes. No dialog appears. A snackbar confirms the path. On mobile, the file is saved locally; you can then share it manually.

7.4 Image Compression

When images are included, each eye photo is compressed before embedding to keep the PDF file size manageable:

- Maximum width: ****2,000 pixels****
- JPEG quality: ****85%****

Very large iriscopes images (e.g. Dino-Lite at full 5 MP resolution) are automatically downscaled. This keeps typical PDF sizes in the 1-4 MB range without a visible loss of clinical detail in the printed output.

7.5 Regenerating a PDF

Any past scan stored in Scan History can have its PDF regenerated at any time:

1. Open Scan History (`Ctrl + H` on Windows, or the Scan History button).
2. Tap the scan record.
3. The full results screen reopens with all stored data.
4. Tap the PDF button to generate a fresh report.

The regenerated PDF will use the ****current**** app language and the ****current**** clinic name setting, which may differ from the original scan if settings have changed since.

8. Settings & Customization

Settings are stored via SharedPreferences and persist across app restarts. On Windows they survive app updates. There is no dedicated Settings screen – all settings are accessible from the **title-bar menu** (Windows) or the **main menu** on mobile.

8.1 Complete Settings Reference

Camera & Capture

Setting	Default	Options / Range	Effect
Preferred camera	Dino-Lite	`dino_lite`, `usb_camera`, `auto_detect`	Pre-selects the camera source on the camera mode selector page
Default zoom	1.0x	1.0x - 4.0x	Starting zoom level applied when the standard camera opens

The zoom slider maps a stored value of 0.0-1.0 to a display range of 1.0x-4.0x (formula: $display = 1.0 + stored \times 3.0$). Setting zoom to 0 stored = 1.0x display (no zoom).

Report & PDF

Setting	Default	Effect
Auto-save PDF	Off	Save PDF automatically at end of every analysis
Include images in PDF	On	Embed OD/OS photos in the PDF; turn off to reduce file size

Analysis Display

| Setting | Default | Effect |

|-----|-----|-----|

| **Show ML comparison** | On | Displays the ML model's raw output values alongside the classical CV result on the results screen, for practitioner reference |

| **Show zone overlay** | On | Enables the interactive polar zone overlay on the iris photo on the results screen; tap zones to see finding details and add observer notes |

Practice Information

| Setting | Default | Effect |

|-----|-----|-----|

| **Practice / Clinic name** | *(empty)* | Text entered here (or on the patient info form) appears as a teal banner in every report header |

Natural Medicine Modules

| Setting | Default | Effect |

|-----|-----|-----|

| **Herbal mode** | Off | Enable herbal recommendation panel and PDF section |

| **Nutrition mode** | Off | Enable 7-color diet nutrition panel and PDF section |

| **Chiropractic mode** | Off | Enable chiropractic spinal correlation panel and PDF section |

| **TCM mode** | Off | Enable Traditional Chinese Medicine meridian panel and PDF section |

All four therapy toggles are independent. Enable only the modalities relevant to your practice.

8.2 Language

The app ships with 15 languages. Change the language from the language selector (globe icon in the title bar on Windows, or the language option in the main menu on mobile).

```
| Code | Language |
|-----|-----|
| `en` | English |
| `es` | Spanish |
| `pt` | Portuguese (Portugal) |
| `pt_BR` | Portuguese (Brazil) |
| `fr` | French |
| `de` | German |
| `it` | Italian |
| `ja` | Japanese |
| `ko` | Korean |
| `zh` | Chinese (Simplified) |
| `ar` | Arabic |
| `hi` | Hindi |
| `pl` | Polish |
| `ru` | Russian |
| `tr` | Turkish |
```

The language preference is remembered between sessions. The PDF report follows the active language at export time (see Section 7.2).

> **Note on right-to-left languages:** Arabic (`ar`) uses a right-to-left text direction. All UI panels and PDF sections are correctly mirrored for RTL reading in the Arabic locale.

8.3 Zone Overlay & Observer Notes

When **Show zone overlay** is on, the iris photo on the results screen displays an interactive polar overlay. Each clock-hour sector is tappable:

- Tap any zone to open its detail panel showing all FLAT/PROT/ANW findings in that zone, the associated organ system, and a text field for **observer notes**.
- Each tapped zone is **automatically appended** to the Observer Notes field in the format `Zone Name – Organ System`. Tapping the same zone twice will not create a duplicate entry.
- Additional free-text commentary can be typed directly in the Observer Notes field alongside the auto-populated entries.
- Observer notes are included as a named section in both the TXT report and the PDF report under "Observer Notes / Zone Overlay".
- Notes are session-local – they are not stored in the database between sessions.

Iris Sign Finder (Add Finding)

Below the Observer Notes field, an **Add Finding** panel allows the practitioner to record structured iris sign observations for the currently selected zone. This is based on the Bexel IRINA clinical classification system.

Workflow:

1. Tap any zone on the polar overlay – the zone name and organ system are displayed and locked.
2. Tap the amber **Add Finding** header to expand the panel.
3. Select an **Anomaly type** from the dropdown. Organ-specific types appear at the top of the list automatically:

Anomaly type	Notes
---	---
Stroma change	Structural fibre changes; select a subtype
Organic pigment spot	Pigmentation deposits; auto-generates clinical conclusion
Slagging	Microcirculation / connective tissue changes; auto-conclusion
Toxic radii	Radial sulci patterns; select a subtype
Heterochromia	Pigmentation variations; select a subtype
Scurf rim *(lung zones only)*	Local intoxication indicator; auto-conclusion
Adaptive rings / arcs *(lung zones only)*	Bronchospastic predisposition; auto-conclusion
Autonomous wreath anomaly *(cardiac zones only)*	ANW irregularity in cardiovascular zones

4. If the selected type has **subtypes**, tap the appropriate chip (e.g. *Lacunae*, *Hyperemic sulci*, *Sectoral hyperpigmentation*).

5. Types with known clinical significance display an automatic **Conclusion** text drawn from the iridology reference database.

6. Tap **Add to Notes** – a structured entry is appended to the Observer Notes field in the format:

```
[Zone Name] Anomaly type > Subtype
→ Clinical conclusion text (if applicable)
```

7. The picker resets automatically, ready for the next zone finding.

> **Note:** Clinical terminology (*Stroma change*, *Lacunae*, *Hyperemic sulci*, etc.) is intentionally kept in the original Latin/Greek form as standard iridology reference language, regardless of the app's display language. The panel UI labels (*Add Finding*, *Anomaly type*, *Subtype*, *Conclusion*, *Add to Notes*) are fully localised into all 15 supported languages. Additional organ-specific sign types will be added to the database in future updates.

8.4 ML Comparison Panel

PupilMetrics runs two separate ONNX models in parallel during analysis.

****1. PI ratio model (\cnri_model.onnx\)****

When ****Show ML comparison**** is enabled, the results screen shows a secondary card beneath the main analysis card for each eye. This card displays the raw ONNX model output:

```
| ML output | Description |
|-----|-----|
| PI ratio (ML) | The model's independent pupil-to-iris ratio
estimate |
| ML Plausibility | The ML component of the hybrid confidence score |
```

> ****Note (v6.1+):**** \cnri_model.onnx\ was updated to a single-output architecture – it now predicts PI ratio only. The Ellipseness (ML) and Decentration (ML) outputs listed in previous versions were removed from this model; ellipseness and decentration measurements in the main results card are computed by the classical CV pipeline.

This panel is intended for practitioners who want to compare the ML PI ratio estimate with the classical CV result. In routine clinical use it can be left on without any negative effect.

****2. ML Iris Deformation Analysis (\deformation_model.onnx\)****

A second ML model runs automatically for every analysis. Its results appear as a purple-bordered card at the bottom of each eye analysis card – no settings toggle required; the card appears whenever the model loads successfully.

The model predicts a **12-element angular deformation vector** – one value per 2-hour clock-window around the iris circumference:

Segment	Clock window	Segment	Clock window
hr0	11:30 - 1:30	hr6	5:30 - 7:30
hr1	12:30 - 2:30	hr7	6:30 - 8:30
hr2	1:30 - 3:30	hr8	7:30 - 9:30
hr3	2:30 - 4:30	hr9	8:30 - 10:30
hr4	3:30 - 5:30	hr10	9:30 - 11:30
hr5	4:30 - 6:30	hr11	10:30 - 12:30

Each element is a deformation percentage: **positive values** indicate expansion or protrusion at that clock segment; **negative values** indicate flattening or compression.

The card displays:

- A 12-bar mini chart with positive bars above the baseline and negative bars below
- **ML Deformation Peak**: the largest absolute deformation value and its clock-window label
- **ML Deformation Mean**: average deformation across all 12 segments

Technical details:

- Input: 224 x 224 iris crop using the same ImageNet normalisation and iris-guided crop as `\cnri_model.onnx\`; preprocessing runs in a background isolate
 - Integrity: SHA-256 checksum is verified on every app launch; a mismatch silently disables the card without affecting core analysis
 - Both ONNX models initialise in parallel at startup
- > **Research caveat**: The deformation vector is a research-level output. Its clinical correlation with specific iris sign types is under investigation at CNRI. Use for longitudinal within-patient comparison only – do not apply absolute values for clinical decision-making.

8.5 About & Support

Access the About dialog from the title bar (Windows: help menu → About) to view:

- App version
- CNRI protocol reference
- Copyright notice (© 2024-2026 PupilMetrics Research)
- Links to the CNRI website and Privacy Policy
- Support email: `helpdesk@cnri.edu`

8.6 Advanced Research Toolkit Settings

All new tools introduced in Version 6.1+ are off by default unless noted. Each can be toggled independently.

Setting	Default	Options	Effect
----- ----- ----- -----			
Gabor chip enabled	On	On / Off	Adds/removes the Gabor chip on the Analysis Results screen
Gabor scales	4	1 - 6	Number of spatial frequencies in the Gabor bank
Gabor orientations	8	4, 6, 8, 12	Number of orientations in the Gabor bank
LBP chip enabled	On	On / Off	Adds/removes the LBP chip
LBP radius	1	1, 2, 3 px	Neighbourhood radius for the LBP operator
3D viewer – default palette	Photo-texture	See §3.10.2E	Starting palette for the 3D relief viewer
3D viewer – default mesh density	Medium (128 ²)	Low · Medium · High · Ultra	Starting mesh resolution
Inpainted image in overlays	Off	On / Off	Use specular-inpainted image for all texture overlays
Crypt detector enabled	Off	On / Off	Auto-detect and report crypts in results & PDF

| **Crypt detector minimum size** | 0.3 mm | 0.2 - 0.8 mm | Size threshold for reported crypts |

| **Contraction furrow detector** | Off | On / Off | Auto-detect nerve rings |

| **Iris signature recording** | Off | On / Off | Record iris signature for session verification |

| **Multi-frame fusion default** | Off | On / Off | Default capture mode sets multi-frame on |

| **PLR – extended analysis** | On | On / Off | Compute T75, hippus, and spectral analysis on PLR captures |

9. Clinical & Legal Disclaimers

9.1 Intended Use

PupilMetrics is a **research and educational tool** for licensed healthcare practitioners trained in iridology, natural medicine, or related fields. It is designed to assist in the observation and documentation of iris and pupil features as part of a broader clinical assessment.

PupilMetrics is **not** a medical device. It is not approved, cleared, or certified by any regulatory authority (FDA, CE, TGA, or equivalent) for diagnostic use in any medical context.

9.2 Not a Medical Diagnosis

All measurements, findings, and reports generated by PupilMetrics – including PI ratio, ellipseness, decentration, zone findings, ANW assessments, anisocoria readings, age-normative comparisons, hybrid confidence scores, and all therapy panel content – are:

- **Observational and educational only**
- **Not diagnostic conclusions**
- **Not a substitute for a clinical examination** by a licensed medical or allied health practitioner
- **Not intended to guide, change, or replace any medical treatment**

The practitioner using this software is solely responsible for all clinical decisions made in connection with its output.

9.3 Therapy Panel Disclaimers

Each therapy panel carries its own disclaimer that also appears in the PDF report:

```
| Panel | Disclaimer text |
|-----|-----|
| Herbal | "Herbal suggestions are provided for educational
purposes only. Consult a qualified healthcare practitioner before
use." |
| Chiropractic | "Chiropractic information is provided for
educational purposes. Consult a licensed chiropractor for diagnosis
and treatment." |
| TCM | "TCM information is provided for educational purposes.
Consult a licensed acupuncturist or TCM practitioner." |
| Nutrition | Dietary information follows the 7-Color Diet
educational framework. Individual nutritional needs vary; consult a
registered dietitian for personalised guidance. |
```

Herb-drug interactions exist. Herbal recommendations must never be applied without first reviewing the patient's current medications and medical history with a qualified practitioner.

9.4 PLR Video Mode

The Pupillary Light Reflex (PLR) video mode carries an additional research-only disclaimer:

```
> "Results are NOT medical diagnoses. Consult a healthcare
professional."
```

PLR analysis is an experimental feature. Velocity, amplitude, and latency measurements depend on ambient lighting, camera frame rate, and flash consistency. They should be interpreted only by practitioners trained in pupillometry and only as one component of a full clinical picture.

9.5 Data Privacy

All patient data – names, ages, scan records, images – is stored ****locally on the device only****. No patient data is transmitted to CNRI servers, cloud services, or any third party. License validation communicates only the machine-generated license key and activation status; no patient identifiers are included.

The practitioner is responsible for ensuring that local data storage and any subsequent sharing of exported reports complies with applicable patient privacy laws (HIPAA, GDPR, Australian Privacy Act, etc.) in their jurisdiction.

9.6 Image Retention

Captured eye images are stored as files in the app's local storage directory. Deleting a scan record from Scan History removes the database entry but does ****not**** automatically delete the image files from disk. To fully remove a patient's data, the practitioner must also delete the associated image files from the device's file system.

9.7 Intellectual Property

The iris zone reference chart and clinical threshold data are based on Dr. Bryan K. Marcia's 2004 CNRI Reference Charts. The herbal database is derived from CNRI knowledge base materials. The ONNX models (`cnri_model.onnx` and `deformation_model.onnx`) are proprietary to CNRI. All content is © 2024-2026 PupilMetrics Research. Unauthorized distribution, reverse engineering, or extraction of any embedded database or model is prohibited.

9.8 Research-Only Disclaimers for Advanced Features

All tools added in Version 6.1+ extend – and are subject to – every disclaimer in the existing Section 9. In addition, the following research-only notices apply specifically to the advanced toolkit:

Texture analysis tools (Gabor, LBP, GLCM, Frangi). The texture metrics are computed from pixel intensity and image gradient information. They are influenced by capture lighting, white balance, and camera characteristics. Values should be interpreted longitudinally within the same patient and same device; cross-device and cross-practitioner comparisons require calibration that is not performed by PupilMetrics.

Automatic detection tools (crypts, contraction furrows, heterochromia sectors). Automatic detections are algorithmic suggestions, not clinical findings. Every detection should be visually verified by the trained practitioner. Detections falling below the reported confidence threshold are particularly prone to false positives from specular reflection, eyelash shadow, or image noise, even after specular inpainting is applied.

Iris signature & session verification. The iris-signature matching system is an internal record-linkage aid only. It is not a biometric identification system. It must not be used for identity verification, access control, security, forensic, or any regulatory purpose. Signatures are stored locally on the device; they are never transmitted and cannot be exported.

PLR signal analysis. Constriction kinetics, redilation time, hippus, and spectral parameters are experimental research metrics. Reference ranges are derived from published pupillometry literature using laboratory-grade equipment; mobile-camera PLR captures may produce systematic offsets from those ranges. Absolute values must not be used for clinical decision-making; within-patient longitudinal comparison is the intended use case.

Intellectual property. The Gabor, LBP, Frangi, GLCM, and SSIM algorithms are public-domain mathematical methods. The specific parameterisation, clinical interpretation mapping (Fibre Density → constitutional type, LBP histogram → lymphatic/haematogenic classification, etc.), and the iris signature implementation are proprietary to CNRI and © 2024-2026 PupilMetrics Research.

For technical support, email **helpdesk@cnri.edu** or visit **cnri.edu**.