# MEDMONT E300

# CORNEAL TOPOGRAPHER

# USER MANUAL

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# 1. Manual Conventions

In discussing the normal interaction between the software and those involved in a particular operation, exam or exam review, this manual uses the term *Clinician* to refer to the person operating the equipment, and *Patient* to refer to the person undergoing the exam.

A small glossary is included for terminology that either originated with Medmont, or is common usage in corneal topography. It also includes some common terms where they apply to Medmont equipment. It is not a definitive glossary of corneal topography.

# 2. Intended Purpose

The Medmont E300 Corneal Topographer is a computerised Video-keratometer using Placido rings to map the surface of the human cornea. The map is captured in three-dimensions and can be displayed subsequently using a number of representations.

The cornea map can be represented in two-dimensional surface coordinates (Cartesian or Polar) with the third dimension expressed in curvature (mm), optical power (Diopters), elevation (mm), or corneal height (mm). The map is presented as a 2D color map or a 3D perspective. It can be displayed according to different definitions of curvature or elevation. The options are axial curvature and power, tangential curvature and power, refractive power, elevation, corneal height, shape factor, and best-fit radius.

The clinical applications include providing measured corneal data for contact lens fitting, refractive surgery, orthokeratology and general assessment of the corneal surface.

The E300 shall only be used as described in this manual and only for the intended purpose.

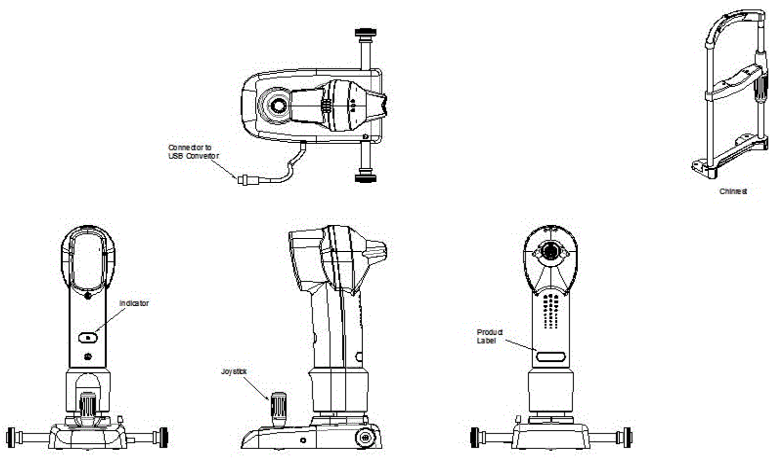



Figure 1. The E300 Instrument.

## Power Connection

A typical power connection between the various units is shown in Figure 2.

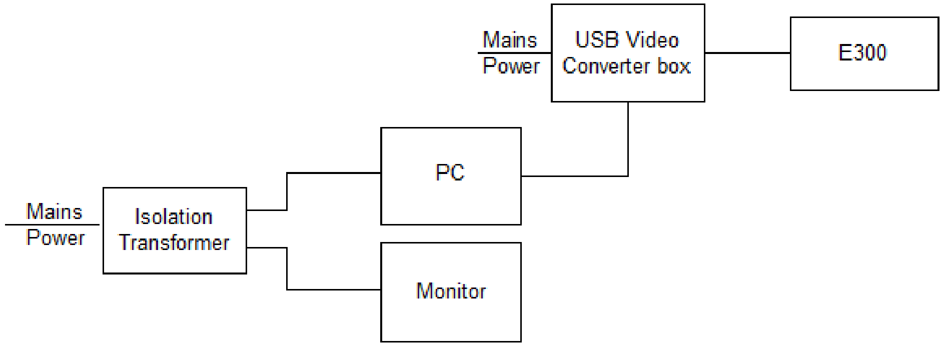



Figure 2. Typical Power Connection.


For the diagnosis, treatment or monitoring of a patient under medical supervision there are three area definitions: Patient Environment, Medically used room and Non-medically used room. Each area demands different electrical safety requirements for your system. Please make sure that your system is set up correctly in the right environment.


When used in a Patient Environment, the PC and its Monitor (if separate, refer to Figure 2) must be powered via a protective isolation transformer, compliant to the governing medical standard IEC60601-1 or UL2601/CSA22.2#601-1 for North America only. A hospital grade power cord must be used to achieve reliable grounding. Tthe Isolation Transformer must be certified either cULus or cCSAus for North America, or UL for US market or CSA for Canadian market or meet National Electrical Regulations.

## Standard E300 Accessories

- USB Video Converter box
- Calibration Object R 8.000mm with mounting screw
- Standard Table Top
- Chinrest
- Instrument Cover

- Accessory box including: 2 Rail covers, 4 mounting screws for chinrest, 2 chinrest pins, 1 box chinrest paper, 2 Caution labels (EN/IEC60950 equipment), Hospital Grade Power Cord (for North America only)
- User Manual including installation Guide
- Medmont Studio Software on CDROM medium
- Calibration file on CDROM

## Optional System Accessories available from Medmont

- TR2450 – Medical Isolation Transformer, 500W, 230/240V Supply
- TR1150-VAR-UL – Medical Isolation Transformer, 500W, 100/120V Supply. For use in North America the customer must supply their own UL/CSA compliant extension cords between the Isolation Transformer and the peripherals (e.g. PC, monitor)
- RS232 COM Port insulation plug
- Network Insulation plug
- Electric Table Model TE 302
- Footswitch

> The combined rating of the PC, Monitor and Peripherals must not exceed the rated power of the Isolation Transformer(s). Each of these accessories may be independently powered by their own Isolation Transformer that meets the required specification.

- DV2000 Diagnostic Video Imaging software module

## Spare Parts

| | |
|---|---|
| Calibration Ball | PN: 0274-370 |

## Consumables

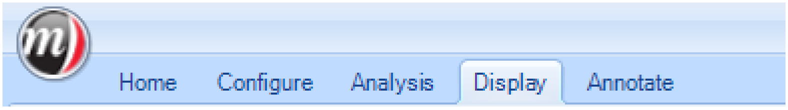
| | |
|---|---|
| Chinrest Paper | Type Sbisa box of 500 |
| Cotton swabs | Tapered double headed on 150mm wooden sticks. Cat No MG 8112-100 bag of 100 |

## The E300 Software

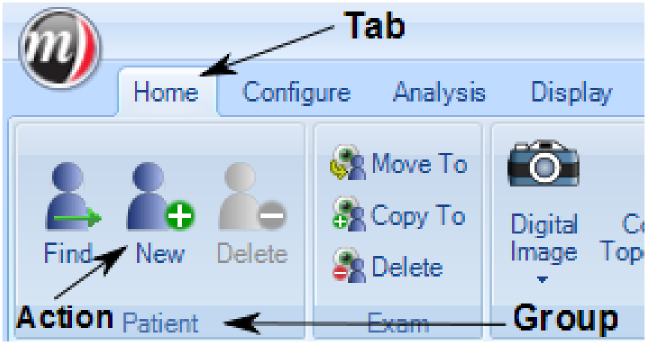
The E300 Software is part of the Medmont Studio integrated software environment. See the Medmont Studio documentation for help on installing and using the Medmont Studio environment.

### Software Conventions

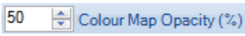
The term **Application Button** refers to the circular button in the top left of the menu bar. This button can have different icons but is always in the same position on the ribbon bar. When navigating the application button menu we use the following notation: **Application Button** > **Import**.




When referring to menu selection, the notation **Home** > **Patient** > **New** means click on the **Home** ribbon bar tab, then look for the **Patient** group on the ribbon bar and click on the **New** icon. This format conforms to the **Tab** > **Group** > **Action** system for identifying menu items in a ribbon bar menu system.




Some keyboard shortcuts can be used when setting spin-box controls like the one shown here. Use the numeric keys for direct entry, up/down arrows for small steps, PgUp/PgDn keys for large steps, and the Home/End keys to move to the opposite end of the currently selected number.



# 3. Warranty

The E300 Corneal Topographer device has been manufactured with all due care and subjected to stringent testing before leaving the factory. The Topographer is guaranteed for 12 months from the date of purchase as evidenced by the invoice. During this warranty period Medmont or an authorised agent will repair or replace all defective parts free of charge. Such repairs do not extend the warranty period. Replaced parts become the property of Medmont. The warranty does not cover defects due to incorrect handling, installation and set up, unauthorised modifications, non-compliance with the requirements for computer hardware and associated mains powered equipment as specified in the Users Manual, loss of the license, loss of income, or service and repair costs for components and associated equipment. Warranty claims are the responsibility of the outlet where the device was purchased.

The warranty and calibration is void, if the QA seal between camera and optics housing is broken.

# 4. Important Facts

The E300 Corneal Topographer is a highly accurate measuring instrument. It measures and maps the surface of the human cornea and represents the results in various quantities and output forms that can be applied in various medical applications. It combines these results with theoretical surface shapes to form the basis for precise contact lens fitting.

## Explanation of Symbols and Labels:


Caution - In event of user error or equipment fault condition there may be a serious risk to health or life of patients or operator, or product damage or loss may occur.

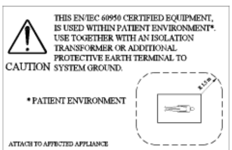

Precaution.

Attention, consult accompanying documents.

Alternating current.

Compliance with the EC Directive 93/42 EEC for medical devices, here shown with Notified Body identification.

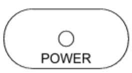
The date below this symbol shows the year and month of manufacturing.




The patient environment comprises a 1.5m radius around the area in which patient or some other person can touch parts of the medical system intentionally or unintentionally. This label is to be attached in a visible position on any EN/IEC 60950 compliant equipment used within the electro-medical system of the E300.

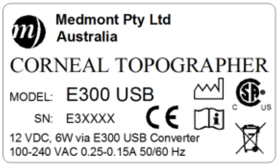
IPX1

Protection against ingress of water.




Power Indicator on rear side of unit. The E300 is powered if indicator is illuminated green, unpowered if un-illuminated.


This label is found on the PC port insulation plugs. These plugs are for RS232 and Network ports, and these ports are to be covered if the PC is used within the patient environment.




E300 Device Label (here shown for the USB variant) - positioned at bottom of base next to cable exit.

## Regulatory Information

This instrument complies with all applicable Regulatory requirements and Safety Standards.

## Classification

In accordance with IEC 60601-1 the E300 Corneal Topographer is classified:

| | |
|---|---|
| Protection against electric shock | Class I |
| Protection against harmful ingress of water | Ordinary (no protection) |
| Mode of Operation | Continuous Operation |

## Clinical Results

This manual **does not** provide guidance on interpretation of clinical results. The clinician must ensure that he or she has received appropriate medical training in such interpretation. For this reason Medmont cannot be held responsible for any misdiagnosis of results.

## Accuracy and Calibration

The E300 is delivered to the end user quality tested, calibrated and as per specifications. It is not the responsibility of Medmont to guarantee or police the accuracy of this instrument after delivery. The E300 is delivered with a calibrated and certified test object with an accuracy based on the national standard. The customer can verify the accuracy of the instrument with the calibration object provided. Medical Regulations require, that the functional accuracy of equipment used for professional purposes be verified every two years. This can be achieved by re-calibrating the test object. Medmont or their authorised agents can provide this service in return for a fee. The E300 must then be re-calibrated by the customer using the newly calibrated test object.

## Radiation

The E300 emits radiation in the visual range for illumination in the distinct wavelength 660nm (red LED cone illumination), 565nm (green LED fixation target) and 430nm (blue LED profile illumination). The levels of intensity of this illumination are less than 50 $cd/m^2$, below any levels known to be hazardous.

## Electromagnetic Compatibility and Emissions

This instrument conforms to the EMC Standard IEC 60601-1-2. The device emits no harmful or undesired electromagnetic emissions.

## Interference

Strong electromagnetic interference from other unprotected devices may affect the performance or results of the E300. If the use of such devices with high electromagnetic emissions cannot be avoided, do not use the E300 and the device simultaneously.

## Side effects

No undesired side effects to patient or clinician or other persons are known when using this instrument under normal conditions and for the intended purpose.

## Electrical safety of medical electrical system

All the equipment connected of the E300 topographer shall be certified to EN/IEC60950. It must be powered by an isolation transformer compliant to the medical standard EN/IEC 60601-1, UL2601 or CSA22.2#601-1 (see *Optional System Accessories available from Medmont* on page 4).

## Disposal

The expected service life of E300 equipment is 8 years. For disposal at the end of the product life cycle please follow national regulations.

# 5. Installation

The installation instructions and this user manual provide guidelines on the installation process. Medmont or Authorised Distributors can provide this service for a fee.  . If a third party installer is commissioned by the customer, only a qualified PC technician should perform the hardware and software installation.

The basic tasks associated with installing the E300 are

- Setting up the Instrument in a suitable environment.
- Installing the Medmont Studio Software.

## PC and Associated Equipment Requirements

When acquiring a PC for the Medmont E300, please observe the minimum requirements as given in the Medmont Studio User manual.


Use only a PC and associated equipment that has been certified to the Standard EN/IEC60950 (Information Technology Equipment) and the Standards for Electromagnetic Emissions CISPR22/EN55022.


If used within a patient environment, power the PC and associated equipment with an EN/IEC60601-1 compliant isolation transformer e.g. TR2450 (230/240V).


Cover any open PC communication ports that have accessible conductors with dummy plugs if used in a patient environment.

## Instrument Environment

The E300 is highly precise measuring equipment and must be located in a suitable and clean environment.

The environmental requirements for the E300 are:

| | |
|---|---|
| *Room temperature:* | *+10°C to +40°C* |
| *Relative humidity:* | *10% to 80%* |

Keep the instrument away from direct sunlight and avoid unnecessary exposure to heat and light. Avoid overly bright rooms to keep stray light level low.

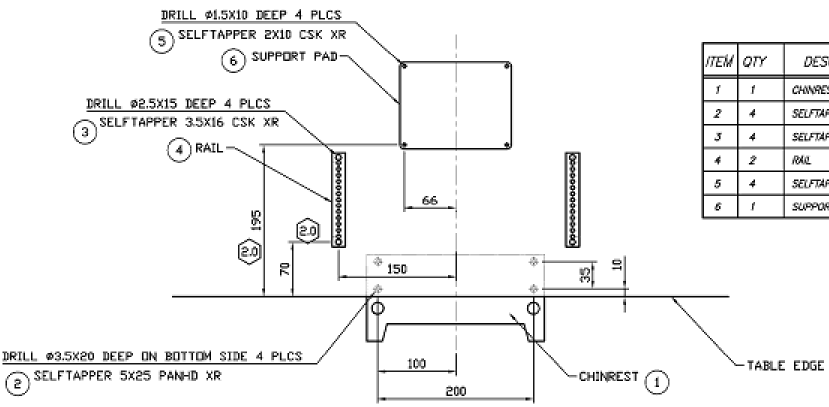
Set up the instrument that any unavoidable bright light sources are opposite the cone opening.

Set up the instrument that all interface and power cables are easy to access. Do not set up the instrument in proximity to devices with high electromagnetic emissions.

CAUTION

Temperatures too low may cause condensation on the optics, while temperatures too high may result in de-calibration of the instrument. After such an event a calibration check is recommended. Strong surrounding electromagnetic fields may affect performance and results of the E300.

It is recommended that the E300 be set up on the Medmont Automatic Table TE300 for optimum positioning flexibility and stability. Customers using their own table should ensure the linear guides are assembled parallel and positioned as per Figure 3, and that the table is adequately secured.




| ITEM | QTY | DESCRIPTION |
|---|---|---|
| 1 | 1 | CHINREST |
| 2 | 4 | SELFTAPPER 5 X 25 PANHD XR |
| 3 | 4 | SELFTAP 3.5 X 16 CSK XR |
| 4 | 2 | RAIL |
| 5 | 4 | SELFTAP 2 X 10 CSK XR |
| 6 | 1 | SUPPORT PAD |

Figure 3. Table setup and dimensions.

## Software Installation

It is important that you read the Medmont Studio manual for additional details on installation.

The E300 software is a part of the Medmont Studio software package. A single CDROM is supplied with installation software for all Medmont Studio components.

- Insert the Medmont Studio CDROM and run the **Setup** program found in the root directory. Select the E300 component when asked which components to install.
- Select the correct frame-grabber hardware for your system.
- Restart the computer when the software installation is complete.

### Running the Software

Select Medmont Studio from the **Start** > **Program Files** > **Medmont** > **Medmont Studio 5** menu or double-click the desktop icon

## Connecting the E300 instrument

The following steps should be followed to connect the Medmont E300 Corneal Topographer to the PC for the first time.

| |
|---|
| Note the E300 Corneal Topographer requires Microsoft© Windows™ XP SP2 or greater to be installed. |

***Connecting the USB Video Converter box***

1. Firstly, connect the USB Video Converter box to the mains power using the supplied mains power cable. Do not switch the unit on!
2. Connect the USB Video Converter box to the PC using the supplied USB cable.
3. Connect the E300 Corneal Topographer 8-pin DIN plug to the USB Video converter box.
4. Turn on the USB Video Converter box.

***Checking the E300 instrument is connected***

1. Open Device Manager. Under Microsoft© Windows™ 7 this can be done by selecting the Windows Logo in the bottom left corner of the main desktop window. Next, right-click while hovering above **Computer** and select **Manage** from the popup menu. When the screen titled *Computer Management* appears, select Device Manager from the *System Tools* menu in the explorer pane (left docked)
2. Expand imaging devices

3. Ensure that the item MEDMONT E300 USB appear in the list of imaging devices as per the screen in Figure 1

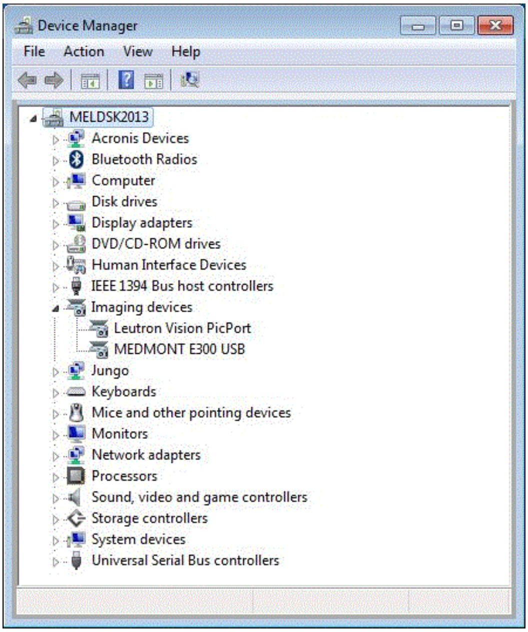



Figure 4. Device Manager showing a successful connection to the Medmont E300 Corneal Topographer

> If the E300 Corneal Topographer does not appear as per these instructions refer to the troubleshooting section in this manual for suggested solutions.

## Registering the E300

You must register your E300 with the software before continuing. Double-click on the **Medmont Studio** desktop icon or Select **Medmont Studio** from the Windows **Start > Programs > Medmont > Medmont Studio 5** menu. A banner with the Medmont Studio logo is displayed while the software loads.

To begin the registration process, click on the **Configure > E300 > Instrument Setup** button. Click **New** to register the instrument. You will be prompted to enter the serial number of your E300 instrument. Enter the serial number (the format should be E30XXX) and press OK.

Next, click the **Import Calibration** button to import the instruments calibration file. You will be presented with a standard Windows file selection menu. Insert the CD-ROM which contains the calibration file into your PC. Once the CD has loaded, browse to your CD-ROM drive, ensure the file with the .ECF extension is highlighted and click **Open**.

From the Instrument setup window, you can select edit to add a comment to the instrument and select **delete** to delete that particular instrument and its configuration. If there's more than one instrument listed, you will need to install the E300 instrument that will be used for E300 exams. This can be done by selecting a particular instrument, then clicking the **Install** button.

It is recommended that ALL instruments are calibrated after their initial setup due to transportation. To calibrate the instrument, select the instrument and click **Calibrate**. For more information about the calibration process, see page 65.

## Disconnecting the E300 instrument

The following steps should be followed to disconnect the Medmont E300 Corneal Topographer from the PC and the Mains Power socket if the USB Video Converter box supplied.

***Disconnecting the USB Video Converter box:***

1. Turn off the USB Video Converter box first.
2. Disconnect the E300 Corneal Topographer 8-pin DIN plug from the USB Video converter box.
3. Disconnect the USB Video Converter box from the PC by removing the supplied USB cable from the PC.

***Disconnecting from the Mains Power outlet***

1. Disconnect mains power by pulling off the supplied mains power cable connected to the USB Video Converter box.

# 6. Testing a Patient

The following sections describe the steps to performing an examination with the Medmont E300 instrument.

## Patient Selection

The recommended practise is to have a patient selected before starting to capture and analyse an exam. Figure 5 shows the Medmont Studio initial display with a patient selected in the explorer pane.

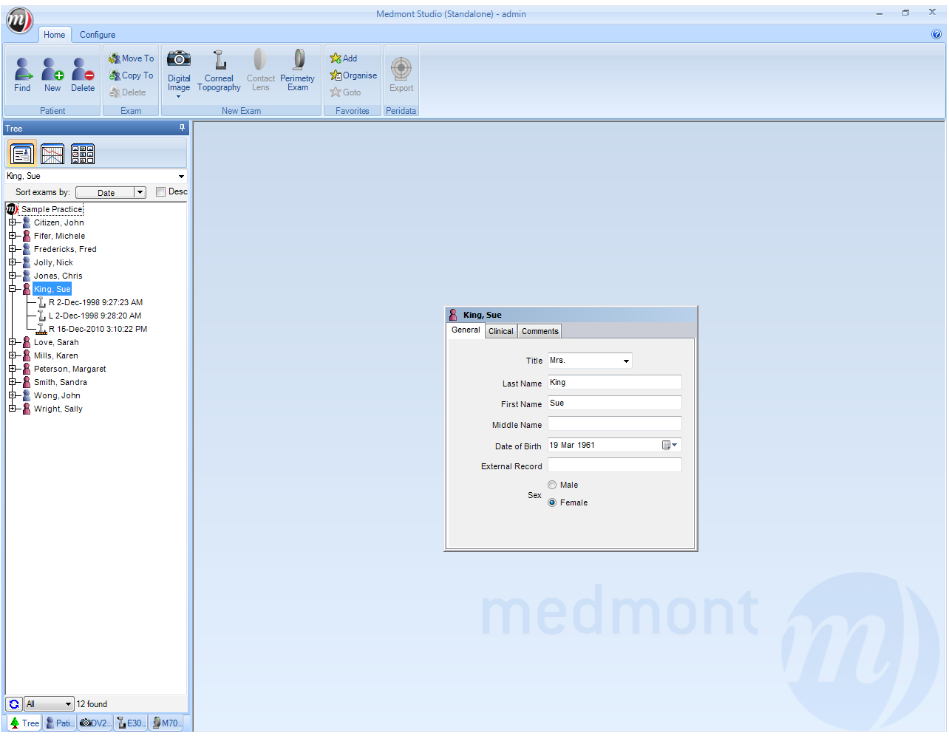



Figure 5. Patient selection.

## Positioning the Patient

In order to capture good quality and accurate images some precautions should be followed in positioning the patient correctly. While these are well-known and standard practice for corneal topography examinations, here we reiterate the most important points as they apply to the E300.

The patient should sit comfortably in the chair. Ask the patient to put her chin onto the chinrest and put her forehead firmly against the forehead rest. She should then push her chin forward on the chinrest. If the patient has deep-set eyes instruct her to move her head back from the headrest. This rotates the eye away from the eyebrow and eyelashes and produces better coverage and fewer interruptions of rings on the upper cornea. Adjust the eye height to the level marks on the chinrest.

Ask the patient to look into the centre of the green fixation target and keep her gaze on this target. The target centre point together with the centre of the ring pattern on the eye defines the Video-Keratoscope axis (VK-axis), the reference axis to which the axial radius/power is calculated (the values for tangential radius/power are less affected by the fixation). If the patient is fixating on the target, the VK-axis is aligned with the line of sight.

When an image is taken with the patient not fixated on the target, the axial power is not referenced to the line of sight, but to an arbitrary axis which may not be reproducible in future exams and may not represent the visual refractive properties of the patient’s eye. In most cases examining the position of the centre of the pupil easily identifies this. For images with good fixation the pupil centre is aligned with the centre of the VK-axis (centre of the Polar and Cartesian grids). If unsure, re-capture the image and view the difference between the two images. Axial power maps are identical for fixated eyes. The tangential power for both images should have their centre in the same position relative to the pupil centre.

Ask the patient to open her eyelid as much as possible and close the other eye if necessary.

## Capturing Patient Exams

Click on the **Home** > **New Exam** > **Corneal Topography** button to display the E300 Capture View (see Figure 7). The red illumination rings inside the E300 cone should turn on. Ensure the **Normal** option is selected in **Home** > **Capture Mode** > **Normal** (Figure 6).

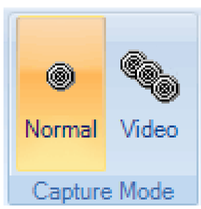



Figure 6. Selecting Normal (single frames) or Video capture control.

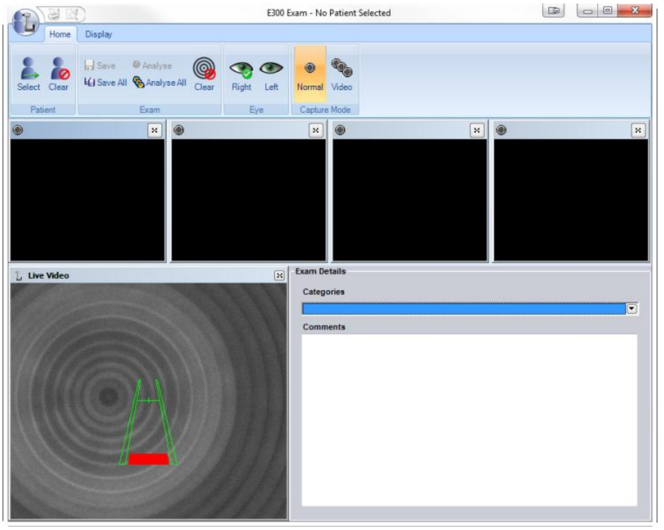



Figure 7. E300 Initial Capture Screen.

Select the eye to be examined in the Exam Details box (the right eye is the default).

The focussing window shows live video from the E300. The green and red target overlaid on the focussing window provides three-dimensional centring and focussing information. The green crosshair indicates the keratoscope axis. The red bar moving along a three-dimensional *runway* indicates the distance of the eye from the optimal focussing plane. The “view” is from the camera’s perspective, so if the red bar is at the top or narrowest part of the runway then the patient is still too far away.

The E300 joystick allows positioning in three dimensions. Move the joystick in the desired direction for movement left and right and for closer to or further away. Rotate the joystick knob for movement up and down, clockwise to raise, anti-clockwise to lower.

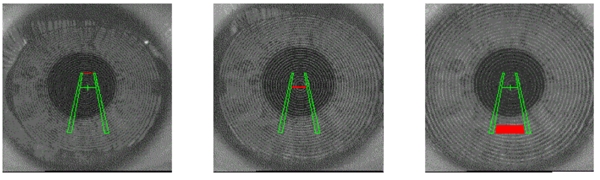


Figure 8. Focus examples showing Too Far, In Focus, and Too Near.

Using the joystick, position the E300 relative to the patient's eye so that the reflection of the Placido rings is centred on the green crosshair, and the red bar is over the horizontal green line. Once this is achieved, the software automatically captures the best set of images and displays them in the image windows along the top of the View pane, with the best images to the right. Images for automatic capturing are selected according to best centring, focussing and least eye movement. Figure 9 shows a typical capture screen display.

It may not be possible to align the red focussing bar over the horizontal cross bar for patients with deep set eyes, because of contact between the bridge of the nose and the instrument. In this case, centre the Placido rings on the green crosshair and bring the red focussing bar as close to the horizontal green line as possible without causing patient discomfort. Provided that the red bar is somewhere within the focussing range (i.e. not at the very end) the software will automatically compensate for the focussing error.

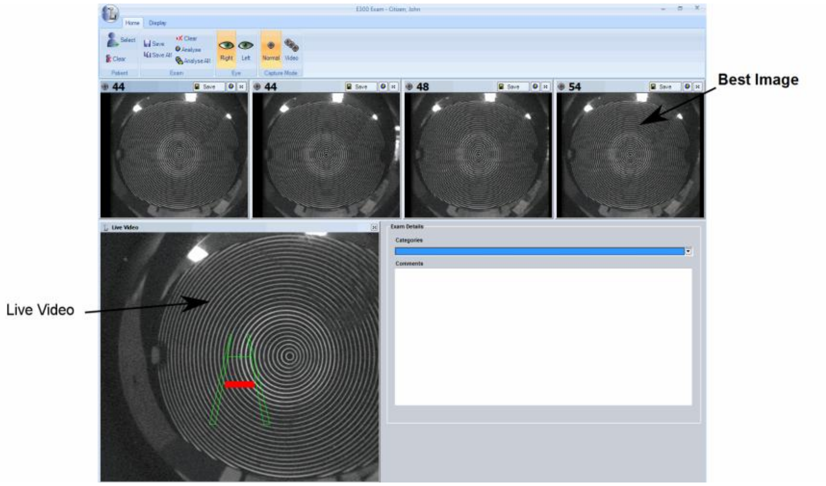



Figure 9. E300 Image Capture View.

## Saving the Best Image

Each image captured is awarded a score out of 100 based on centring, focus and movement. The score is displayed as a large white number above each captured image. A good score for a normal eye will be over 75. Calibration balls can achieve scores of up to 100.

Select the best image from those automatically captured. Typically this will be the right-most image. Click on an individual image's ***Expand/Collapse*** button to expand the image to full-screen. You should consider the following factors when assessing images:

- Patient Fixation– choose images where the pupil is centred with respect to the Placido rings.
- Eyelid Position – choose images where the patient's eyelid does not obscure large portions of the cornea or cause large eyelash shadows.
- Central Ring Clarity – choose images where the central Placido ring reflection is clearly visible. For some patients with extreme conditions, this may require shifting their fixation to get the central Placido ring area over an area with less surface irregularity.

Click on an image's **Save** button to save it. You can also save the set of images by clicking on the **Home** > **Exam** > **Save All** button. Alternatively you may decide to analyse the image before saving. If this is the case then click on the **Home** > **Exam** > **Save** button .

A Patient Exam item is added to the Explorer pane under the current patient. You can save more than one exam if you wish. To view the Exam Results, select the Exam in the Data pane and the View Mode (see *Analysing and Viewing Exam Results* on page 23).

## Capturing Video

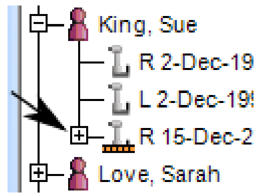
The E300 can capture video at frame rates of up to 25 frames per second (fps). Click on the **Home** > **New Exam** > **Corneal Topography** button to display the E300 Capture View (see Figure 7). The red illumination rings inside the E300 cone should turn on. Navigate to **Home** > **Capture Mode** > **Video** (Figure 10).

Make your selection for the number of maximum frames and the frames per second from the two spin boxes. If previous video images were captured the ***Start*** button will be greyed and you must press the **Home** > **Exam** > **Clear** button to prepare for the next capture sequence.

Ready the patient as before. When focussing and centring are correct, press the **F9** key on the keyboard or click **Start** to start the capture sequence. The E300 will continue capturing until it has either captured the set number of images or the **F9** key or **Home** > **Video** > **Stop** button is pressed again.


Figure 10. Video capture controls.

While the software does not set a hard upper limit on the number of frames to capture, captured images are written to memory, and consequently this will impose a physical upper limit on the number of frames that may be captured.




Once the test has begun, it can be restarted at any point by clicking on **Home** > **Video** > **Restart** . Restart will discard the captured images in the preview window and capture a new set of images using the current capture control setting.

Navigate to **Home** > **Exam** > **Save All** button will save the video against the current patient. A video sequence appears in the patient explorer window as shown above.

## Alternate Methods of Patient Selection

Exams cannot be saved unless a patient is selected. If a patient or a patient exam is currently selected before starting the Capture window, then a new exam is created for that patient. Otherwise the exam is created without reference to a patient.

However, a patient can be selected or deselected from the Capture window while capturing a patient exam. The **Home** > **Exam** > **Clear** button clears the currently referenced patient for the exam. If a patient is currently selected her name is displayed in the caption bar of the window. Click on the **Home** > **Patient** > **Select** button to bring up the **Find Patient** dialog (see Figure 11).

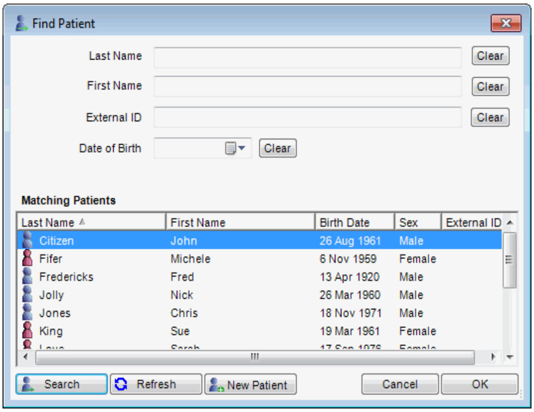



Figure 11. Patient Selection Dialog.

Select a patient from this list and click ***OK***. You can now save an exam against this patient.

# 7. Analysing and Viewing Exam Results

The E300 software provides a variety of ways in which to view exam results. The Exam View mode controls how selected exams are displayed (see *Setting the Exam View Mode* on page 24 ). For each of these modes you can set the type of data to display (see *Changing the View Settings* on page 26 ), and the color mapping (see *Setting Elevation Map* Options on page 36).

## Selecting the Exam Results

The first step in viewing Exam Results is selecting the exam(s) to view. To select the exam for a particular patient, click on the exam symbol or the date of the exam in the Medmont Studio Explorer pane. To select multiple exams hold down the control key while clicking on the symbols.

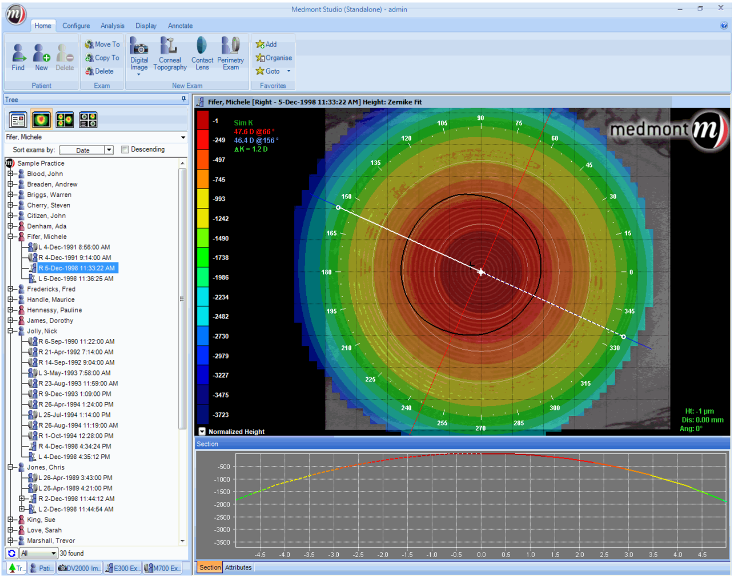



Figure 12. Select and Display an existing exam.

The View pane now displays the exam result(s). Figure 12 shows a single right eye image. How the exams are displayed depends on the current View Mode.

## Setting the Exam View Mode

The View Mode controls how the selected Patient Exams are displayed. You select the View mode from the top of the patient tree.

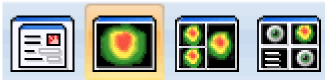


Figure 13 Possible E300 display mode options.

The selections for the various modes are:

### Details View

Click on the  button at the top of the patient tree. This displays textual information about the selected Patient Exam (see Figure 14). It provides for the clinician to add comments and, where an exam has been attributed to the wrong patient, to change the owning Patient (see *Editing Exam Details* on page 63).

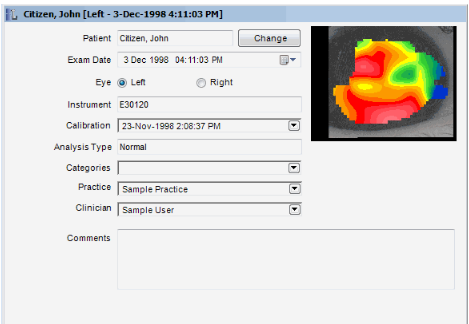



Figure 14. Patient details view.

### Map View

Click on the  button at the top of the patient tree. This displays up to four different selected Patient Exams with the same Map Type (see *Map Type* on page 27) and Color Key (see *Setting Up the Color Key* on page 37). Select multiple exams by first holding down the Control key, then click and drag the mouse over the subject exams. Use the View mode to display full screen color map images of a single exam or to display images of multiple exams.

## Combination View

Click on the button at the top of the patient tree. This view displays four separate views of the selected Patient Exam (see Figure 15). The Map Type and settings for each image can be controlled independently. Use this view for an overview of the corneal data.

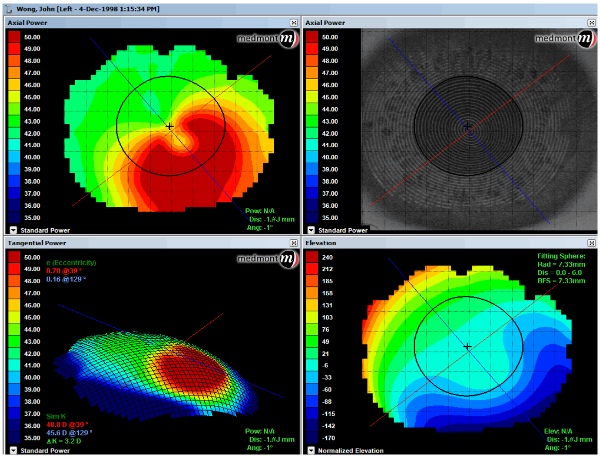



Figure 15. Combination View.

## Compare View

Click on the button from the top of the patient tree. This view displays two selected Patient Exams and the difference between them. Use this view to observe changes over time and healing patterns.

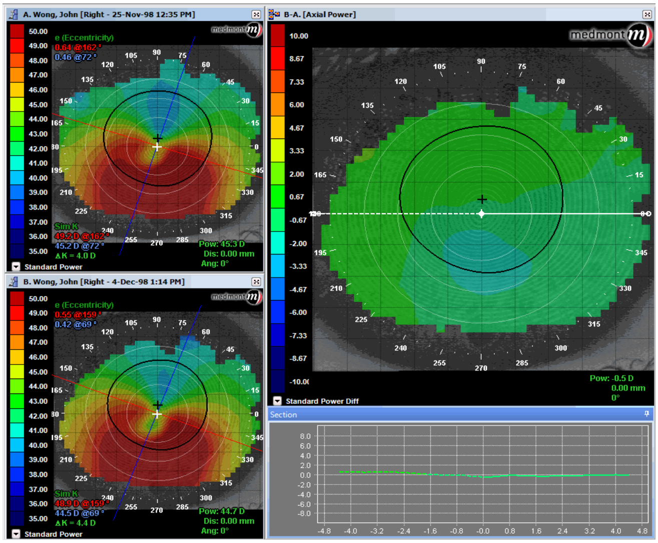



Figure 16. Compare View.

## Changing the View Settings

You can customise the information displayed for a Patient Exam for each Exam View Mode (see *Setting the Exam View Mode* on page 24). Once an exam is selected, the **Display** ribbon bar tab will become available (see Figure 17), allowing you to set both the Map Type to display and for setting a considerable number of options.

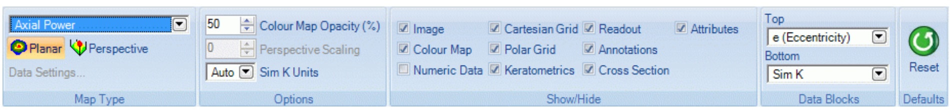



Figure 17. Map view settings dialog.

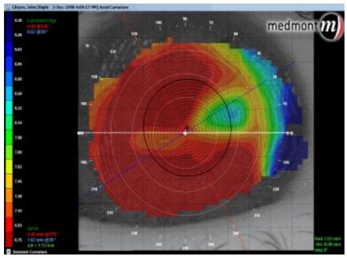
These options are applied to the image as you change them and are immediately visible. You can click at any time on the **Display** > **Defaults** > **Reset** button to restore the software defaults.

## Map Types

The Map Type controls the type of data displayed for a Patient Exam. The types displayed in the following list are selected from the drop-down boxes on the **Display** ribbon bar tab. In each case the images are of the same exam.

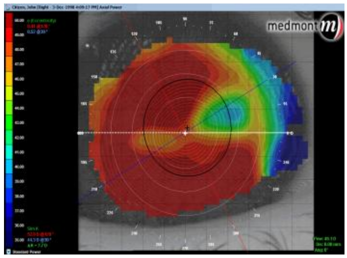
### *Axial Curvature Map*

Displays the curvature of the surface in mm with respect to the keratoscope axis.



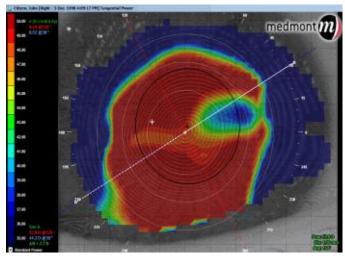
### *Axial Power Map*

Displays the paraxial power of the surface in Diopters with respect to the keratoscope axis.



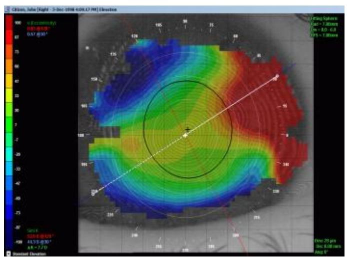
### *Tangential Power Map*

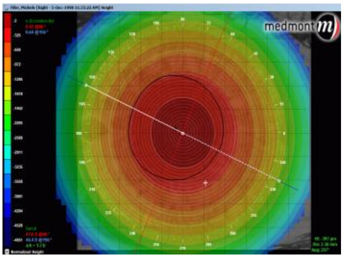
Displays the local paraxial power of the surface in Diopters.



### *Elevation Map*

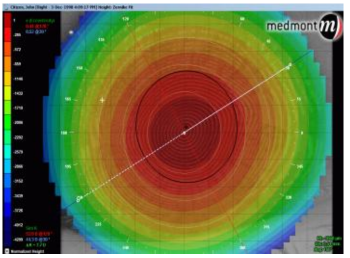
Displays the distance from a specified best-fit sphere to the surface in microns. Positive values indicate the surface is above the best-fit sphere.





### *Height Map*

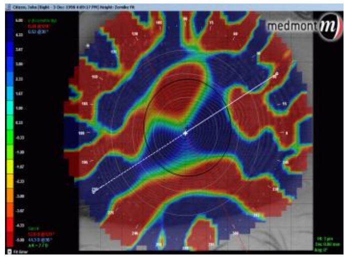
Displays the distance along the axis from the apex of the eye to the surface in microns.



### *Height Map - Zernike Fit*

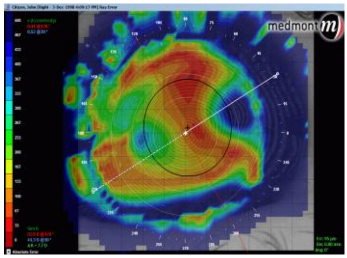
A decomposition of the height data in terms of the Zernike components. These can be added or removed from the display by selecting the **Data Setting…** button underneath the Map drop-down list.

### *Height Map - Zernike Residual*



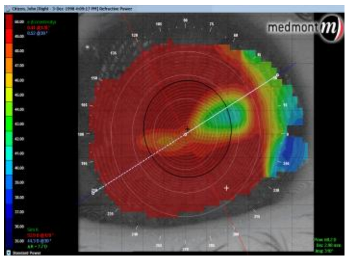

A decomposition of the height data in terms of the Zernike components. These can be added or removed from the display by selecting the **Display > Map Type > Data Setting…** button underneath the Map drop-down list. Selecting **Show Residual** will display the Zernike Residual. This measures the error in fitting the height using Zernike functions:

*Residual = Zernike Height – Height*



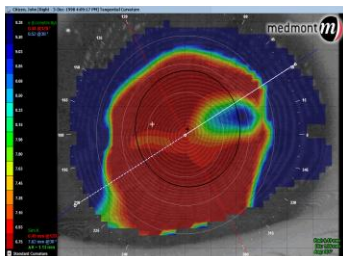

### *Ray Error Map*

The deviation on the image plane between the focal point and a ray from an on-axis distant object refracted through the cornea.




### *Refractive Power Map*

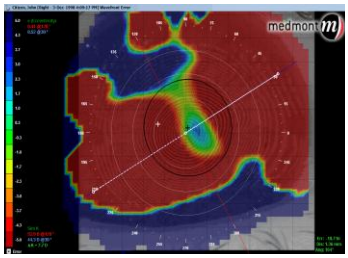
Displays the true refractive power of the surface in Diopters.




### *Tangential Curvature Map*

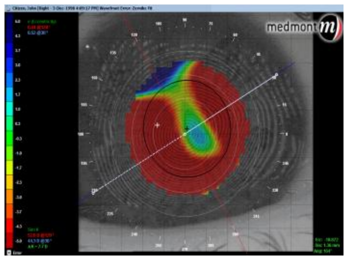
Displays the local curvature of the surface in mm.

### *Wavefront Error Map*



The difference in optical path length of a ray from an on-axis distant object refracted through the cornea and the principle ray (which passes through the centre of the cornea) to an ideal spherical wavefront inside the eye, divided by 550 nm (the assumed wavelength of the light-ray).

### *Wavefront Error Map - Zernike Fit*



This is a decomposition of the wavefront error data in terms of the Zernike components. Individual Zernike components can be added / removed from the display by selecting the **Display > Map Type > Data Setting…** button underneath the Map drop-down list. Selecting **Show Residual** will display the Zernike Residual. This measures the error in fitting the wavefront error data using Zernike functions:

*Residual = Zernike Result – Calculated Wavefront Error*

The data may be viewed as either a two-dimensional plan as above or as a three-dimensional image. These views are selected by clicking the appropriate button:

 Plan – 2-dimensional

 Perspective – 3-dimensional

A 3-dimensional exam view is displayed without the eye image. An example for the same image used above is shown in Figure 18.

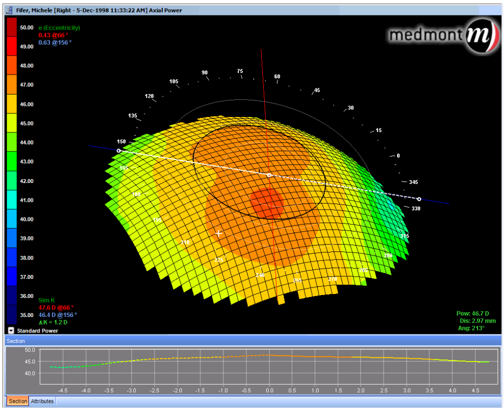
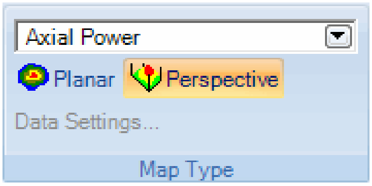



Figure 18. A Perspective or 3-dimensional exam view.

When the Perspective view is selected the **Display** > **Options** > **Perspective Scaling** spin control is enabled and provides for magnifying the vertical perspective scaling (see *Perspective Scaling* on page 36 and *Software Conventions* on page 5).

For the Map View and Compare View modes the **Display** > **Map Type** ribbon bar group (shown below) provides a quick means of changing the map and display type.




For the Combination View mode (Figure 15) a different map type can be selected for each of the four display areas.

The **Display** ribbon bar tab contains a number of controls that can help in interpreting and analysing the exam results. Each of the four display areas has a slightly different set of controls, relating to the particular map chosen (see *Setting the Exam View Mode* on page 24). Activating one of the four sub-views by clicking on it will allow that sub-view to be customised using the options on the **Display** ribbon bar tab.

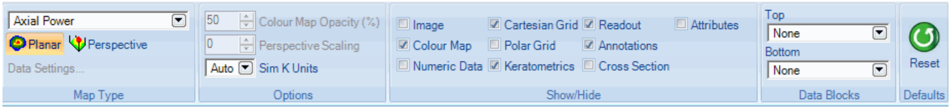



Figure 19. Combination View Settings dialog.

The set of image control options on the **Display** > **Show/Hide** ribbon bar group (Figure 19. Combination View Settings dialog.) are summarised below.

### *Image*

Displays the raw video image. The color map is displayed transparently over the image. You can set the level of transparency with the **Display** > **Options** > **Color Map Opacity** spin box (see *Color Map*  on page 36 and *Manual Conventions* on page 1).

### *Color Map*

Displays the color-mapped data. Disabling the color map allows you to examine the raw video image.

> If you disable one or the other of the **Image** or **Color Map** checkboxes, clicking on the *checked* box will flip the display between these two settings.

### *Cartesian Grid*

Displays a one millimetre rectangular grid, centred on the keratoscope axes, overlaying on the color map.

### *Polar Grid*

Displays a polar reference ring, centred on the keratoscope axis, overlaying the color map.

### *Keratometrics*

Toggles on and off the display of the Keratometrics. The steep axis is calculated as the spoke with the highest average axial power whilst the flat axis is always set at 90 degrees from the steep axis.

### *Cross Section*

Displays a cross-section of the displayed data in a tabbed window below the color map. A white Section indicator line is displayed over the color map to indicate the source of the cross section. The Section line has three handles, which allow you to rotate and translate the line (see *Using the Section Display* on page 43).

### *Attributes*

Displays the attributes associated with this exam in a tabbed window below the color map.

### *Annotations*

Displays any annotations stored with the exam.

### *Readout*

Displays a readout marker (a white cross) over the color map. The location of the readout marker relative to the keratoscope axis, and the data values at that location, are displayed in the bottom right hand corner of the image. The values presented are in terms of the currently selected Map Type (see *Map Type* on page 27). Clicking and dragging with the left mouse button moves the readout marker and updates the readout in real time.

### *Numeric Data*

Toggles on or off the display of numeric data at specific points on each 30 degree spoke. The data displayed at each point will depend on the chosen map type.

## Text Data Blocks

On the left-hand side of each image there is a Top and Bottom block of text data. Two drop-down controls allow content selection for these blocks.

If **Section** is enabled, then clicking on the steep or flat text (see Keratometrics above) moves the Section tool (see *Using the Section Display* on page 43) onto the steep or flat axis.

### *Zoned K*

If Zoned K is selected in either the top or bottom data blocks, then the Zoned Keratometric display will be enabled. The Zoned Keratometric display is divided into 3 zones; 3mm, 5mm and 7mm. Each zone is independently analysed to locate the primary (most steep and most flat) and the secondary (second most steep and second most flat area). The primary steep and flat are indicated by a thick red or blue line, whilst the secondary steep and flat are indicated by a thin red or blue line (respectively).

Unit of measurements can be specified from the **Sim K** units drop down box on the **Display** tab.

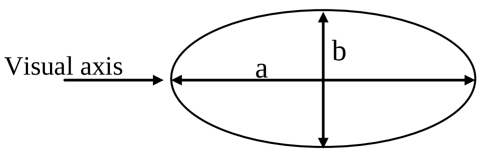
### *Sim K*

This displays the simulated keratometric (Sim K) values for the Steep (in red) and Flat (in blue) axes of the eye, and the *corneal cyl* ΔK (formerly *dk*).

The parameters include a number of changes from earlier versions that bring the E300 terminology more into line with current use. Among others, E Values are now referred to as *e* for eccentricity, corneal cyl was previously dk and is now ΔK, shape factors are now called $e^2$ values. There are also some newer terms such as asphericity ($Q = -e^2$ ) and p values ($p = 1 - e^2$ ). See *Toggles on or* off the display of numeric data at specific points on each 30 degree spoke. The data displayed at each point will depend on the chosen map type.

Text Data Blocks on page 33. The applicability and usage of these terms is particularly well covered in the article “Corneal Asphericity: The e’s, p’s and Q’s of Corneal Shape” by Swarbrick, H. in Refractive Eyecare for Opthalmogologists, December 2004.

Here we define the parameters of a (prolate) ellipse as:




### *e (Eccentricity)*

This are the standard mathematical eccentricity values of the ellipse defined by the shape factors. The E300 computes this from

$$e = \sqrt{1 - \frac{\min(a,b)^2}{\max(a,b)^2}}$$

Note that this *e* term for eccentricity cannot distinguish between oblate and prolate eyes.

### *$e^2$ Values*

Formerly what Medmont called Shape Factor, this displays the elliptical shape index for the Steep (in red) and Flat (in blue) axes of the eye, and is computed from:

$$e^2 = 1 - \frac{b^2}{a^2}$$

### *p Values*

This is another shape factor and attempts to overcome the limitation of the *e* value, and is computed as:

$$p = \frac{b^2}{a^2}$$

Using this shape index, a circle can be described by p = 1, a prolate ellipse has a p-value less than 1, and an oblate ellipse has a p-value greater than 1.

### *Q (Asphericity)*

This shape factor can be used to indicate how far a particular curve departs from sphericity. The value for a sphere (or in two dimensions a circle), is given the value zero, with prolate shapes having negative values, and oblate shapes positive values.

$$Q = p - 1$$

An advantage of Q factor is its being centred on zero for a circle.

## Notes on Shape factors: *e*, $e^2$, *p* and *Q*

The shape factors are useful in partially quantifying aspects of the shape of the eye. They are all derived from an ellipse that approximates a specific cross-section of the eye, typically the steep or flat axis.

### *How is the ellipse approximated?*

Medmont computes the unique ellipse that gives the same axial curvature at a specified chord and apical curvature as the actual eye. In practice this method gives repeatable and reliable shape factor readings.

An alternative method uses height instead of axial curvature, but it is more sensitive to noise, hence less repeatable and less reliable.

### *Can you reconstruct height data from the shape-factors?*

While the original ellipse can be reconstructed mathematically from these parameters, the height information thus obtained describes a crude approximation, rather than the actual eye.

A better alternative is to use the height data obtained from the Height view directly.

### Color Map Opacity

Located at **Display** > **Options** > **Color Map Opacity**. This spin control allows you to set the level of transparency of the color map when it is displayed over the raw video image. A value of 0.0 makes the video image transparent. A value of 1.0 makes the video image opaque.

### Perspective Scaling

Located at **Display** > **Options** > **Perspective Scaling**. This spin control allows you to display 3D Perspective views with enhanced distortion. The deviation of the eye surface from the best-fit sphere is multiplied by the scaling factor and added to the original surface. A value of zero produces a "true" 3D Perspective.

### Sim K units

Located at **Display** > **Options** > **Sim K units** this allows the user to select the units of measurement for the resulting data in both the top and bottom data blocks when Zoned K or Sim K have been selected. Options are: mm (millimetres), D (Diopters), or Auto K, which will automatically select the best unit of measurement based on the chosen map type.

### Setting Elevation Map Options

When the Elevation map type is selected, the **Display** > **Options** > **Data Settings…** button is displayed to allow elevation related settings to be changed. This is shown in Figure 20.

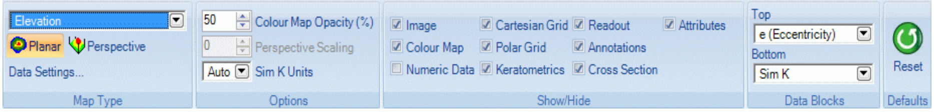



Figure 20. Elevation map view settings dialog showing the additional Elevation Settings button.

Clicking on the **Display** > **Map Type** > **Data Settings** button displays the Elevation Settings dialog shown in Figure 21. This has additional controls for manipulating the elevation Fitting Annulus and Best Fit Sphere.

The **Elevation Fitting Annulus** inputs allow you to specify the boundaries of the annulus used by the software to calculate a best-fit sphere. The calculation is based only on the eye surface contours covered by this annulus. The **Inner Radius** defines the size of the annulus inside diameter, and thus defines how much of the central eye surface will be ignored. The

**Width** sets the annulus width, and defines how much of the eye surface outside the inner diameter is used in the computation. The best-fit sphere is the one passing through the eye surface defined by the annulus and minimising the surface elevations on either side.

For example, to view changes induced by surgery or Ortho-K to the central zone of the eye, set the inner radius to 3 mm and the width to 1 mm. The sphere will be fitted to the data in the 3-4 mm radius zone, which will not change significantly before and after surgery, thus providing a stable baseline for comparison.

By default the software uses the best-fit sphere when calculating elevation data. However you can force it to calculate the elevations from a sphere of a radius you specify by deselecting the **Use Best Fit Sphere** option. Being able to specify a fixed radius can be useful when displaying elevation differences to ensure that both exams use the same baseline elevation.

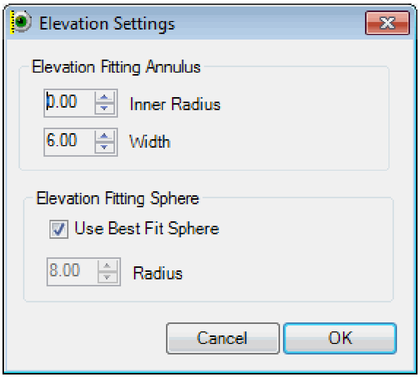



Figure 21. Elevation Settings dialog.

## Setting Up the Color Key

The color keys control the mapping of data values to colors. There are two types of Color Keys: Standard - used to convert data values into colors, and Difference - used to convert the difference between data values into colors. Difference color keys are always balanced about zero, i.e. the minimum color key value is the negative of the maximum value and zero difference is always the same color (light green).

### Standard Color Keys

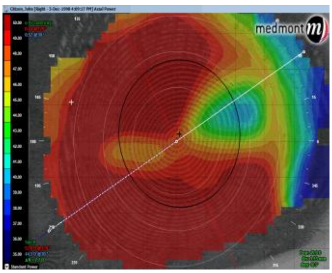
The E300 provides a number of predefined color keys for each map type.

| Map Type | Available Color Keys |
|---|---|
| Axial Power | Standard Power, Normalized Power, Universal Standard Scale, K Scale |
| Tangential Power | Standard Power, Normalized Power, Universal Standard Scale, K Scale |
| Axial Curvature | Standard Curvature, Normalized Curvature |
| Tangential Curvature | Standard Curvature, Normalized Curvature |
| Height | Standard Height, Normalized Height |
| Refractive Power | Standard Power, Normalized Power, Universal Standard Scale, K Scale |
| Elevation | Standard Elevation, Normalized Elevation |

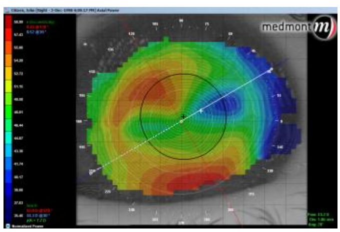
## Color Key Descriptions

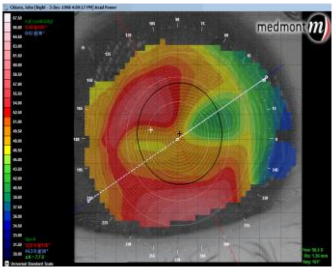
There are seven standards based Color Keys. Three apply to the Map types.

**Standard Power** – The standard Medmont E300 color mapping for refractive power values in Diopters to color. Similar to the USS scale but with a restricted range.

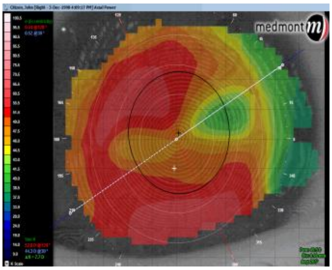


**Normalized Power** – A normalized scale for mapping refractive power values in Diopers to a color scale using a linear Color Key such that it's upper and lower bounds correspond to the limits of the data in the image.





**Universal Standard Scale (USS)** – An implementation of the proposed Universal Standard Scale for Corneal Topography by Smolek, Klyce & Hovis. Maps refractive power values in Diopters to color.



**K Scale** – Similar to the Keratron™ scale for mapping refractive power values in Diopters to color.

Additional color scales are:

- **Standard Curvature** – Maps the axial and tangential curvature values in mm to color.
- **Standard Elevation -** Maps the elevation values in microns to color.
- **Standard Height** – Maps the corneal height values in microns to color.
- **Fluorescein** – Maps the contact lens fitting clearances in microns to the Fluorescein color scale.
- The current Color Key type is displayed at the bottom left of each map display. The keys are selected from the drop down box that appears by clicking on the down arrow beside the text (see Figure 22).

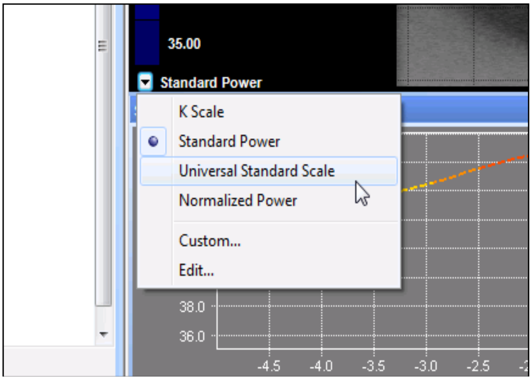



Figure 22. Selecting the current Color Key.

## Custom Color Keys

You can customise the color key to highlight a particular aspect of an exam. Drop down the Color Key selection box (see Figure 22) and click on the **Custom…** entry. This will present the **Custom Settings** dialog shown in Figure 23. The **Base Color Scale** text box shows the base scale of the currently selected key and the three spin boxes show that key's parameters (see *Manual Conventions* on page 1).

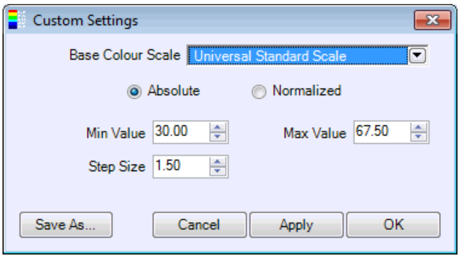



Figure 23. Color Key Custom Settings dialog.

The radio buttons provide for switching between **Absolute** and **Normalized** versions of the current Color Key. The **Absolute** setting displays the data in the current image mapped into a fixed range of colors that defines the selected Color Key. The **Normalized** setting linearly re-scales the current Color Key so that its upper and lower bounds correspond to the limits of the data in the image. An example is shown in Figure 24 for the Universal Standard Scale key.

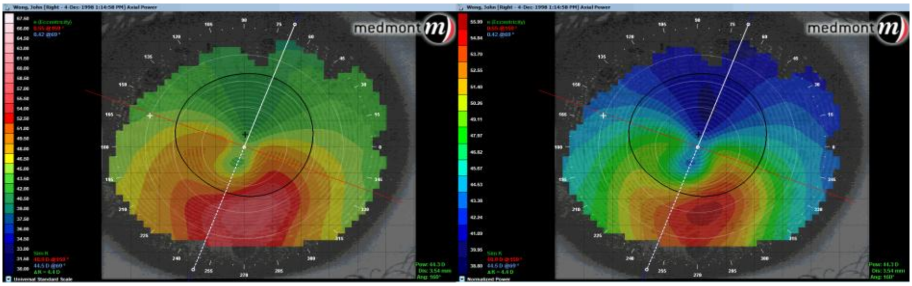


Figure 24. An example showing the difference between an Absolute (on the left) and a Normalised Color Key.

## Difference Color Keys

There are three predefined difference color keys:

- **Standard Power Difference** – Maps the axial, tangential and refractive power differences in Diopters to color.
- **Normalized Power Difference –** Maps the axial, tangential and refractive differences in Diopters to a linear color scale using a maximum and minimum corresponding to the data being mapped.
- **Standard Curvature Difference** – Maps the axial and tangential curvature differences in mm to color.
- **Standard Height Difference** – Maps the elevation differences in microns to color.

The current Difference Color Key type is displayed at the bottom left of a Difference map display, similar to a standard map view (like Figure 22). The **Custom Settings** dialog is the same as shown in Figure 23. For difference views the result of normalising the color key will usually show a more dramatic change because the differences typically have a smaller range. Figure 25 demonstrates on the left an Absolute color key with the expanded scale around zero, and on the right a Normalized color key of the same image showing the color key re-mapped from the standard –100 to +100 to cover just the image data range. Note that the scale will always be symmetrical about zero, even if the data is not.

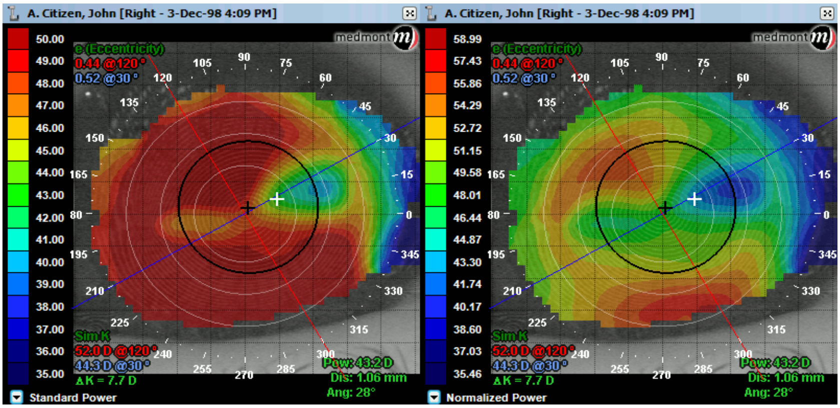



Figure 25. An example difference between two exams, showing how the differences visible with the Absolute Color Key on the left, can be highlighted with a Normalised key on the right.

## Zooming and Panning

You can zoom and pan the currently displayed Patient image by navigating to the **Display** > **Zoom/Pan** ribbon bar group. You can use the **Display** > **Defaults** > **Reset** item to reset the default image view.

When multiple images are displayed zooming and panning of the images is synchronised. The Capture focus window can also be zoomed but not panned, as the keratoscope axis must always be visible for focussing.

### Using the Mouse to Pan and Zoom

You can also use the mouse to pan or zoom within a single image. If the mouse is fitted with a wheel, the wheel is always enabled as zoom control. You can also change the cursor mode by pressing the spacebar, clicking the right mouse button within the image and selecting an option from the popup menu or by navigating to the **Display** > **Zoom/Pan** ribbon bar group. The shape of the cursor will change to reflect the current cursor mode.

In **Pan** mode, click on the image and drag the mouse in the direction you wish to move the image. The image will continue to move in that direction while the mouse button is down or until a boundary is reached. The speed and direction of movement is proportional to the distance of the current cursor position from the position when the mouse button was pressed.

In **Zoom** mode, click on the point in the image that you wish to zoom in on. The image will continue to zoom in while the left mouse button is held down. If you hold the ***Ctrl*** key down while clicking then you zoom out instead of in.

## Using the Section Display

The section display (see the lower part of Figure 26) provides a graph of a user-selected cross-section through an image map. You enable the section display as described in *Cross* Section (page 32).

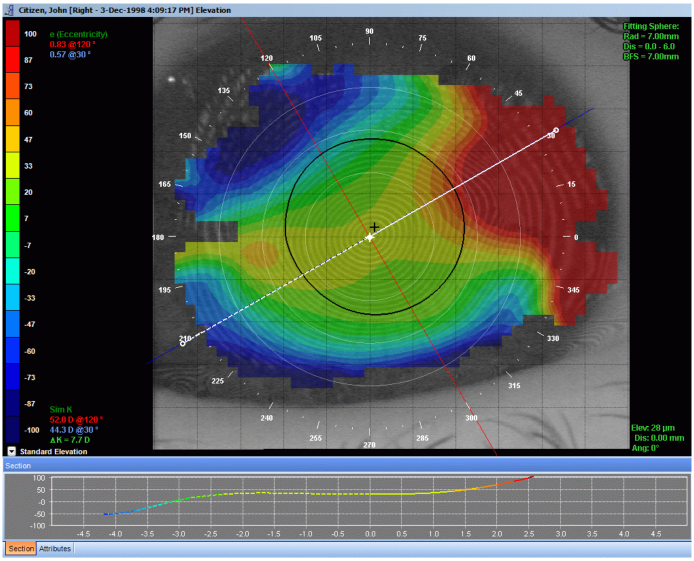



Figure 26. The Section Display

The white section indicator line on the image shows the location of the cross section data source. The dotted half of the indicator corresponds to the dotted portion of the cross section data. The indicator has three handles. Use the left mouse button to click and drag the handles to a new location. Rotate the cross-section about its centre using the outer handles. Move the cross section through the image using the centre handle. The cross section data updates dynamically as the handles are dragged.

The vertical axis of the Section graph covers the same range as the current color key. Note that the image may contain data that is outside the currently selected color key, resulting in parts of the section graphic being clipped at the window edge(s). If you need to see the entire graphic, use the ***Normalize*** button in the color key Custom Settings dialog (see *Custom Color Keys* on page 40).

If Keratometric values are displayed in a data block, then click on the steep and flat values to move the section indicator and Section tool to the corresponding steep/flat meridian.

## Displaying Analysis Details

The Analysis Details dialog provides numerical readouts of various analysis parameters at a specified meridian and chord for the currently selected exam(s). Note that you can select more than one exam to analyse.

Click on the **Analysis** > **Show** > **Details** button to display the Analysis Details dialog (see Figure 27). This displays the corneal height, shape factor and apical curvature at the selected chord and meridian. The ***Steep*** and ***Flat*** buttons set the meridian to the steep and flat axis respectively.

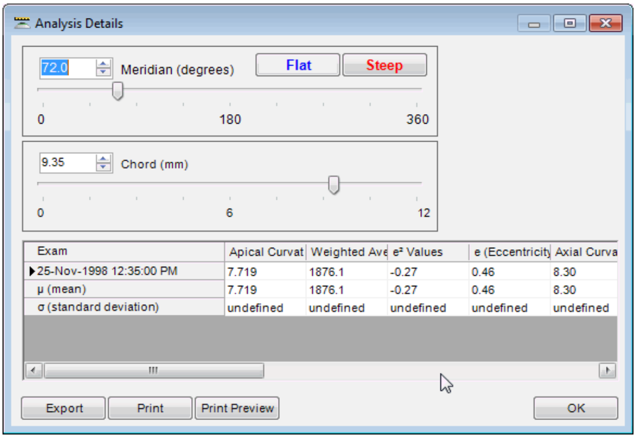



Figure 27. Analysis Details Dialog.

The tabulated data shows the values for the currently selected exam. The statistical measures of mean and standard deviation are also given.

The section and readout indicators of displayed exams are linked to the Meridian and Chord slider to provide visual feedback of the measurement location. This means that if the Section tool is displayed, clicking and dragging the Meridian slider will rotate the Section indicator line on the Map view to a matching angular position, with the attribute display reflecting the data under the white data point cross. Similarly, clicking and dragging the Chord slider will move the cross along the Section indicator line. Alternatively, with this dialog displayed, dragging the Section indicator line around will move the dialog sliders correspondingly. The data point cross will be displayed even if the Section tool is not.

While you can use the lower scroll bar to scroll through the tabulated attributes, the dialog itself can be resized to display more or less of the tabulated data. First move the cursor over an edge of the dialog. When it changes to a double-headed arrow, click and drag the edge as required. You can also click and drag a column divider in the **Exam** row to vary the column's width.

The weighted Average Height column displays the weighted average of the corneal height at either end of the specified chord. The weighting is designed to correct for corneal tilt – this allows the value to be used in 3rd party software that assumes a symmetric eye model.

The ***Export*** buttons produces a comma-separated file (.CSV) readable by most spreadsheets.

## Exam Filters

Exam filters allow you to restrict which Exams are shown in the Explorer pane. Select the E300 Exams tab at the bottom of the Explorer pane and the select the Filter entry as shown in Figure 28.

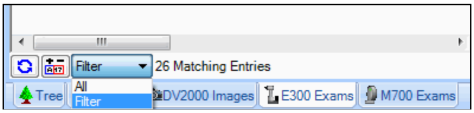



Figure 28. E300 exam filter selection.

This displays the dialog shown in Figure 29 and shows the many criteria that may be used for exam filtering. You can also define your own selection criteria in the Advanced filter tab.

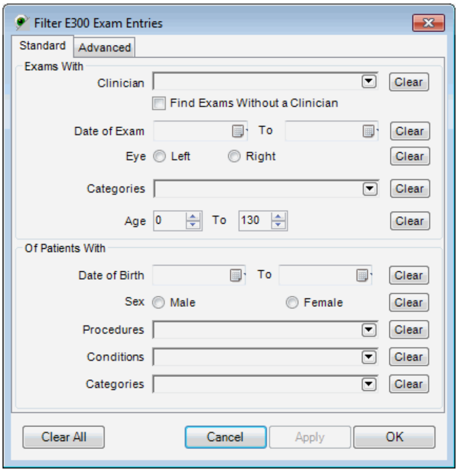
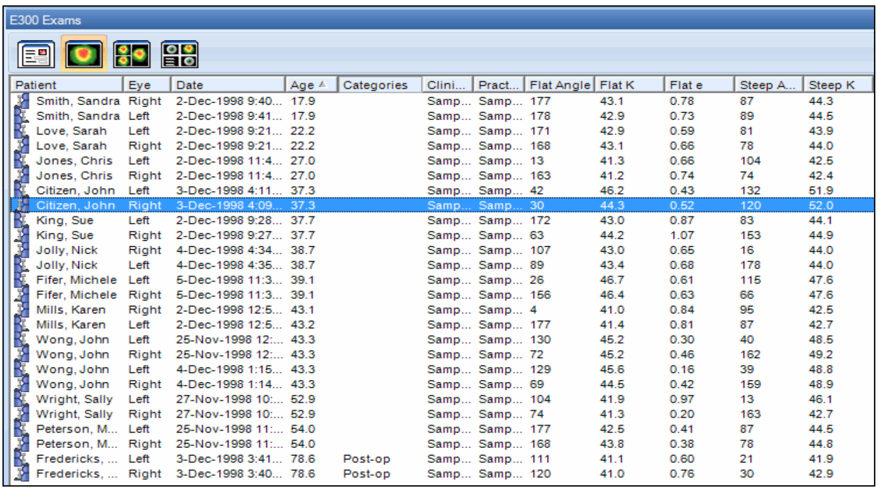



Figure 29. E300 exam filter selection dialog.

## Sorting E300 Exams

The E300 Exams displayed in the Explorer pane can be sorted by any of the column headings when the E300 Exams tab is active. Click on the heading for any column and the display will show exams sorted by entries in that column. Click again to reverse the sort order. Figure 30 shows an example of sorting exams by patient age.


E300 Exams

| Patient | Eye | Date | Age | Categories | Clini... | Pract... | Flat Angle | Flat K | Flat e | Steep A... | Steep K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Smith, Sandra | Right | 2-Dec-1998 9:40... | 17.9 | | Samp... | Samp... | 177 | 43.1 | 0.78 | 87 | 44.3 |
| Smith, Sandra | Left | 2-Dec-1998 9:41... | 17.9 | | Samp... | Samp... | 178 | 42.9 | 0.73 | 89 | 44.5 |
| Love, Sarah | Left | 2-Dec-1998 9:21... | 22.2 | | Samp... | Samp... | 171 | 42.9 | 0.59 | 81 | 43.9 |
| Love, Sarah | Right | 2-Dec-1998 9:21... | 22.2 | | Samp... | Samp... | 168 | 43.1 | 0.66 | 78 | 44.0 |
| Jones, Chris | Left | 2-Dec-1998 11:4... | 27.0 | | Samp... | Samp... | 13 | 41.3 | 0.66 | 104 | 42.5 |
| Jones, Chris | Right | 2-Dec-1998 11:4... | 27.0 | | Samp... | Samp... | 163 | 41.2 | 0.74 | 74 | 42.4 |
| Citizen, John | Left | 3-Dec-1998 4:11... | 37.3 | | Samp... | Samp... | 42 | 46.2 | 0.43 | 132 | 51.9 |
| Citizen, John | Right | 3-Dec-1998 4:09... | 37.3 | | Samp... | Samp... | 30 | 44.3 | 0.52 | 120 | 52.0 |
| King, Sue | Left | 2-Dec-1998 9:28... | 37.7 | | Samp... | Samp... | 172 | 43.0 | 0.87 | 83 | 44.1 |
| King, Sue | Right | 2-Dec-1998 9:27... | 37.7 | | Samp... | Samp... | 63 | 44.2 | 1.07 | 153 | 44.9 |
| Jolly, Nick | Right | 4-Dec-1998 4:34... | 38.7 | | Samp... | Samp... | 107 | 43.0 | 0.65 | 16 | 44.0 |
| Jolly, Nick | Left | 4-Dec-1998 4:35... | 38.7 | | Samp... | Samp... | 89 | 43.4 | 0.68 | 178 | 44.0 |
| Fifer, Michele | Left | 5-Dec-1998 11:3... | 39.1 | | Samp... | Samp... | 26 | 46.7 | 0.61 | 115 | 47.6 |
| Fifer, Michele | Right | 5-Dec-1998 11:3... | 39.1 | | Samp... | Samp... | 156 | 46.4 | 0.63 | 66 | 47.6 |
| Mills, Karen | Right | 2-Dec-1998 12:5... | 43.1 | | Samp... | Samp... | 4 | 41.0 | 0.84 | 95 | 42.5 |
| Mills, Karen | Left | 2-Dec-1998 12:5... | 43.2 | | Samp... | Samp... | 177 | 41.4 | 0.81 | 87 | 42.7 |
| Wong, John | Left | 25-Nov-1998 12:... | 43.3 | | Samp... | Samp... | 130 | 45.2 | 0.30 | 40 | 48.5 |
| Wong, John | Right | 25-Nov-1998 12:... | 43.3 | | Samp... | Samp... | 72 | 45.2 | 0.46 | 162 | 49.2 |
| Wong, John | Left | 4-Dec-1998 1:15... | 43.3 | | Samp... | Samp... | 129 | 45.6 | 0.16 | 39 | 48.8 |
| Wong, John | Right | 4-Dec-1998 1:14... | 43.3 | | Samp... | Samp... | 69 | 44.5 | 0.42 | 159 | 48.9 |
| Wright, Sally | Left | 27-Nov-1998 10:... | 52.9 | | Samp... | Samp... | 104 | 41.9 | 0.97 | 13 | 46.1 |
| Wright, Sally | Right | 27-Nov-1998 10:... | 52.9 | | Samp... | Samp... | 74 | 41.3 | 0.20 | 163 | 42.7 |
| Peterson, M... | Left | 25-Nov-1998 11:... | 54.0 | | Samp... | Samp... | 177 | 42.5 | 0.41 | 87 | 44.5 |
| Peterson, M... | Right | 25-Nov-1998 11:... | 54.0 | | Samp... | Samp... | 168 | 43.8 | 0.38 | 78 | 44.8 |
| Fredericks, ... | Left | 3-Dec-1998 3:41... | 78.6 | Post-op | Samp... | Samp... | 111 | 41.1 | 0.60 | 21 | 41.9 |
| Fredericks, ... | Right | 3-Dec-1998 3:40... | 78.6 | Post-op | Samp... | Samp... | 120 | 41.0 | 0.76 | 30 | 42.9 |

Figure 30. E300 exams sorted by Age.

## E300 Attributes

The Attributes view (see Figure 31) provides a summary of the derived attributes of the currently selected exam. Some examples are:

- **Score** – a computed number that combines the measurements of how well centred the captured image was, how well focused the captured image was, and of how much movement there was in the captured image (1.0 = optimal).
- The **Flat Angle** and **Steep Angle** are the angles of the flat and steep keratometric axes.
- The **Surface Asymmetry Index** (SAI), which increases with increasing asymmetry in corneal power distribution.
- The **Surface Regularity Index** (SRI), which increases as central corneal irregularity increases.
- **BFS Radius** – the radius of the best fit sphere (note that this is affected by the current Elevation Fitting Radius (see *Setting Elevation Map Options* on page 36).
- **IS Index** – this is a measure of the difference between the average inferior and superior power in the eye.
- **HVID** – this is a measure of the horizontal visible iris diameter. You will need to manually define an iris for this attribute to be defined.

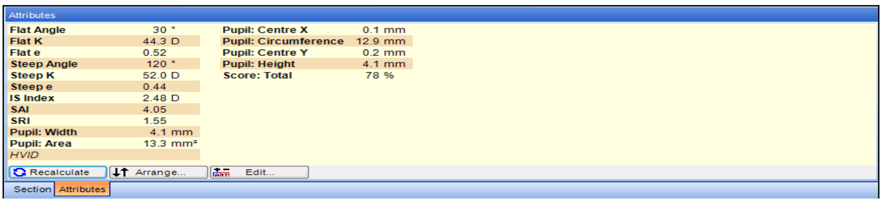



Figure 31. E300 attributes window.

### Arrange Attributes

The **Arrange Attributes** dialog shown in Figure 32 controls which attributes are displayed and the order in which they are displayed. The **Available** column on the left is the list of available attributes, while the **Selected** column on the right is the list of those attributes selected for display. You can move any or all from one side to the other using the arrow keys in the centre. The single arrows will move a selected attribute from the **Available** list to the **Selected** list, or remove it from the **Selected** list. The double arrows will move the entire **Available** list to the **Selected** list, or completely clear the **Selected** list.

The up and down arrows on the right allow for changing the order in which the selected attributes are displayed. The top item will be the first attribute displayed. Selecting an attribute in the **Selected** list and then clicking on the up arrow will move that attribute towards the top of the list.

Some statistics are not applicable to all exam types. There will also be some pre-Medmont Studio exams that will be missing the later statistics. These attributes are normally shown in italics with no value. By un-checking the ***Show Undefined Attributes*** check box these particular attributes will automatically be removed from the list.

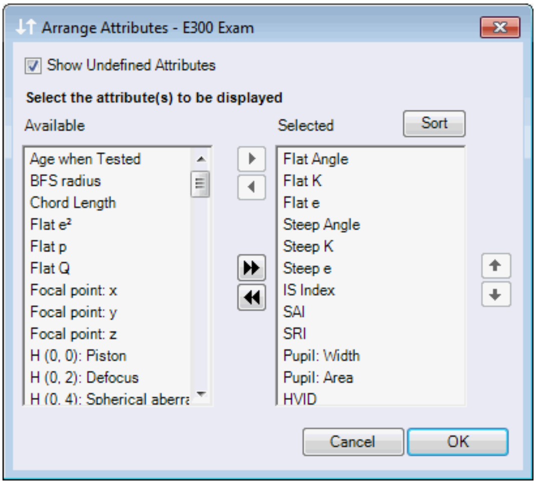



Figure 32. Arrange Attribute dialog.

Note that the underline character embedded in many attribute names is displayed as a space on the map display.

Clicking the ***Sort*** button will sort the Selected attributes column into alphabetical order. You can see the effect of any changes made in this dialog by clicking the ***Apply*** button. Clicking ***OK*** will also apply any changes and dismiss the dialog.

## Custom Attributes

You can define your own attributes to extend this standard set. Access the Attributes control dialog on the **Configure** tab, by clicking **Attributes**.

The Attributes dialog is shown in Figure 33 and shows the same set of names in the **Name** column as is shown in the **Available** column in Figure 32. The **Description** column shows the derivation of that particular attribute. For example the **Flat Angle** attribute depends for its value on the *FlatAngle()* system function. The system functions have direct access to the current exam details.

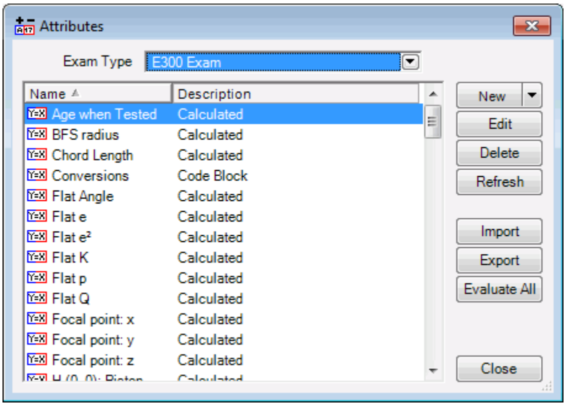



Figure 33. Attributes Control dialog.

To explore how you can define your own attributes, we will change the **Flat Angle** attribute to display in radians. First ensure the **Flat Angle** attribute is highlighted in the **Attributes** dialog (Figure 33) and then click on the ***Edit*** button. This will bring up the **Edit Calculated Attribute** dialog shown in Figure 34. Position the cursor after the text in the Expression edit box and add "* 0.01745". Now the **Flat Angle** attribute is going to return radians. We need to make the display match this fact so change the "°" text in the **Units** box to "rad", and change the **Decimal Places** setting from "1" to "3". At this point the expression editor should look like Figure 35.

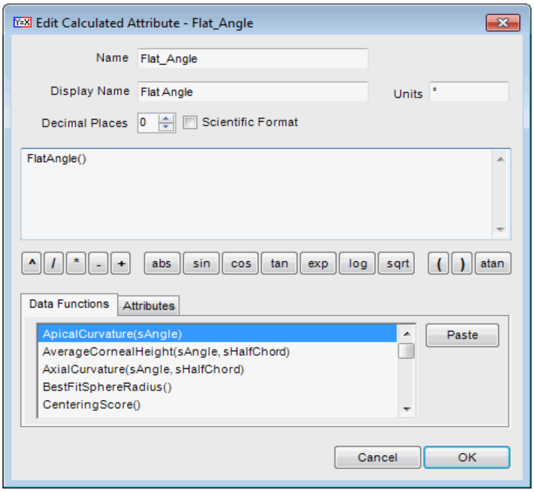



Figure 34. Edit Calculated Attribute dialog.

When you are satisfied with this, click on the ***OK*** button to copy the new expression to the attributes database. Click on the ***Close*** button in the **Attributes** dialog, and then force an attribute re-computation by clicking the ***Recalculate*** button. You should see the **Flat Angle** attribute now display in radians.

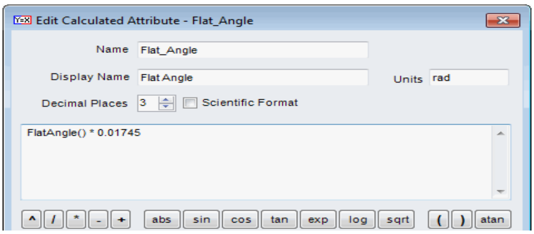
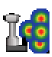



Figure 35. Revised calculation to display Flat Angle in radians.

This is probably not the way you would want **Flat Angle** to display, so repeat the above procedure and reverse the changes. Insert the degree symbol ° by holding down the Alt key and typing 167 on the numeric keypad.

## Creating a Composite Exam

The  Create Composite Eye function allows you to combine multiple E300 exams for the same patient into a single composite exam. This can be useful for extending the coverage of the E300 by combining several off-axis exams (left/right/up/down) with a central exam to maximize the analysed coverage area. It can also be used to improve the accuracy of the instrument and minimize transient tear film effects by providing an exam which is the average of several exams.

Select the exams that you wish to combine. Ensure that the pupil was correctly detected in each exam. If necessary redefine the pupil using the **Annotate** > Add Attribute > Pupil button. Click on the **Analysis** > Create > Composite Eye button. The software aligns the axes of each of the selected exams with most central exam (the exam with the pupil closest to the instrument axes) and creates a composite exam by combining the aligned exam data.

## Creating an Idealized Eye

The Create Ideal Eye function allows you to create an idealized symmetric, toric ellipsoidal surface based on the average values of the currently selected exam(s). This can be useful when fitting some contact lens designs that are based on a symmetric ellipsoidal model of the eye. It creates a new exam, which also allows you to compare the real surface with the best-fit toric/ellipsoid surface to visualize higher order visual defects.

Select the exams you wish to base the idealized eye on, click on the **Analysis** > Create > Ideal Eye button. The software calculates the average steep and flat angles of the selected exams and creates a toric ellipsoidal surface based on the average height values at a set chord along these axes. The chord used is that set for measuring shape factors in the E300 Options dialog (see *Setting Elevation Map Options* on page 36). Note that, unlike the Composite Eye function, the selected exams are not aligned to a common axes before being averaged. The Ideal Eye function should therefore only be used on a single exam or exams where the pupil is aligned.

## Adding Annotations

Graphical annotations can be added to E300 exams using the options in the **Annotate** ribbon bar tab. The **Display > Show/Hide > Annotations** check box must be checked to enable annotations.

Annotations are stored with the exam and may be printed, exported, and imported.

Annotations can also be added to the comparison view of two exams. In this case the annotation is stored and the next time the same two exams are compared the annotation is displayed.

### Text Annotations

Clicking on **Annotate** > **Add Annotation** > **Text** changes the cursor to allow you to place a text annotation on the image. Click at the location to place the anchor for the annotation (the left-hand end of the text). The Text Annotation dialog (see Figure 36) is then displayed, allowing you to enter the text to be displayed.

You can use the various controls to change the **Font**, **Background** color, no background color (**Transparent**), **Text Color**, and **Test alignment** and **Vertical** position.

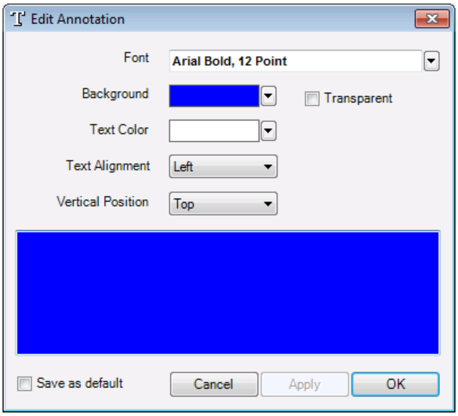



Figure 36. Text Annotation Dialog.

### Callout Annotations

Clicking on **Annotate** > **Add Annotation** > **Callout** changes the cursor to allow you to place a text callout annotation on the image. This consists of a text label and line pointing to the selected anchor location. A dialog similar to Figure 36 is displayed to allow you to enter the text for the annotation.

### Shape Annotations

The **Annotate** > **Add Annotations** ribbon bar group includes a number of shapes you can use to delineate areas in the image. These are **Circle**, **Ellipse**, **Rectangle** and **Square**, with an additional three tools for drawing polygonal **Areas**. The shapes are shown in the Medmont Studio user manual. You can also draw a ruler that resembles a **Callout** annotation where the callout is automatically the current length of the ruler in mm.

The Area drawing tools all work in a similar way to each other. The **Annotate > Add Annotations** > **Polygon** tool draws a straight line between each point you define by pressing the left mouse button. Press the right mouse button to automatically close the polygon boundaries. The **Annotate > Add Annotations** > **Curved** tool does the same only it passes a smoothing curve through the defined points. The **Annotate > Add Annotations Freehand** tool is just that – click and hold the left mouse button and draw the shape you want.

## Annotation Attributes

The system will automatically attempt to define the pupil, and this is visible as a black polygon if the **Display > Hide/Show > Annotations** checkbox is ticked (see Figure 17). You can re-define the pupil by clicking on the **Annotate > Add Attribute > Pupil** button. You can define the iris by clicking on the **Annotate > Add Attribute > Iris** button. The Pupil is a curved area annotation the Iris is a circle annotation.

When you create Iris and/or Pupil annotations, the system automatically adds a number of attributes, including default text. You can edit these as shown below.

## Editing and Deleting Annotations

You can move and edit any shape or text. For shapes, point and click anywhere on the shape outline and it will change color and show small white circles at all vertexes. Left click anywhere on the outline *except* on a vertex and you can move the entire shape. Alternatively you can click and drag the central cross. For Area annotations, click on a vertex and you can move that vertex independently of the others. For Circles, Squares, etc, this will re-scale the annotation. The lines joining the vertex will automatically follow.

To edit a **Text** annotation, double click on the annotation or click on **Annotate** > **Selection** > **Edit** and the editor will be displayed, allowing you to change the text or attributes. You can move text by clicking and dragging using the mouse.

To delete an annotation, select the annotation by clicking once on it and then clicking on the **Annotate > Selection > Delete** button. You can also right-click the mouse button and select **Delete Annotation**.

### Saving and Abandoning Changes

Changes and additions you make while working with an exam are not automatically saved. You will notice that as soon as you add an annotation, two buttons will appear on the **Annotate** > **Changes** ribbon bar group; the ***Save*** and ***Undo*** buttons. Use these buttons to control the saving or not of any current work. If you do not use either, the system will display a warning dialog when you attempt to move away from the edited image.

## Removing Artefacts

It is now possible to remove known artefacts from E300 maps. If tear film or other artefacts are present on the eye being examined, they can be removed using this tool.

Select an E300 exam from the tree view and click on the **Analysis** > **Data Points** > **Edit** button. If raw analysis data is not already present, the exam will be re-analysed. This will enable the eraser tool:

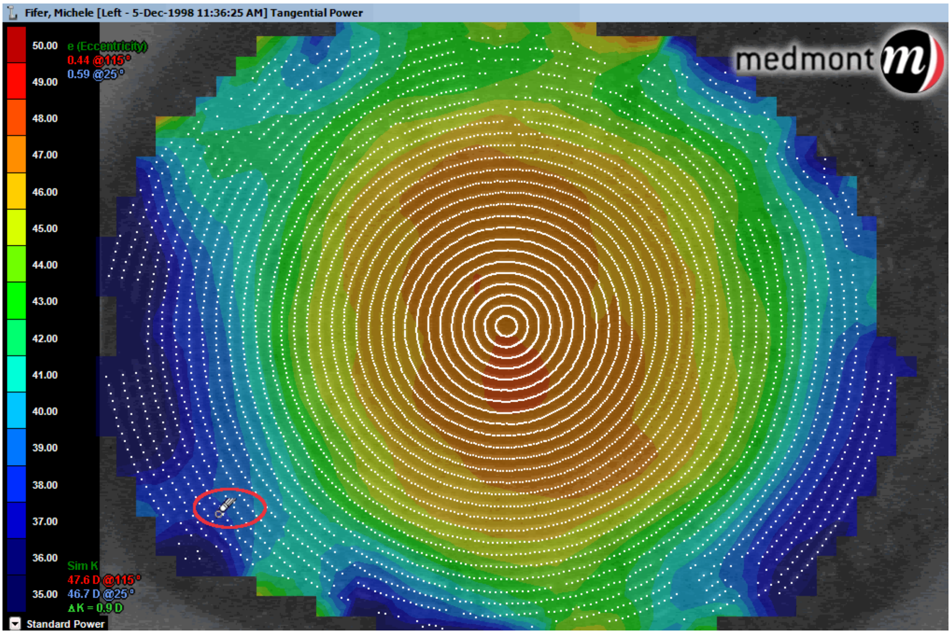



Figure 37. Eraser Tool

With the eraser, click and drag over any points you wish to remove from the map. When clicked, the white dots (active test points) will be replaced with black dots (inactive test points):

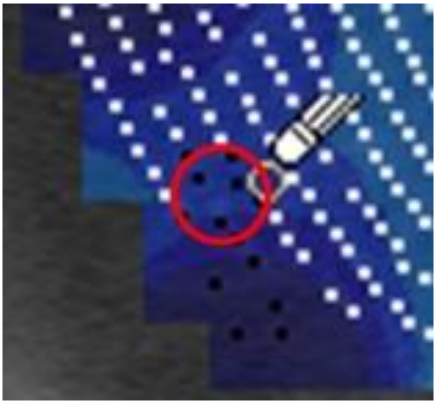


Figure 38. Deleted Points

If you wish to restore a deleted point, hold down the **Ctrl** key and click again on that point with the eraser tool. The point will once again be included in the colour map.

To apply changes made with the eraser tool, click on **Analysis > Data Points > Remove Selected** button . The colour maps and statistics are recalculated excluding the selected points.

If needed, you can always reset the analysis back to its original form on the Analysis menu, by clicking **Reset.**

## Printing the Exam Results

Select the Patient Exam(s) you wish to print then select the View (see *Setting the Exam View Mode* on page 24), and Map Type (see *Map Type* on page 27).

Select the printer and paper size to print by clicking on the **Application** button and selecting **Print** and then clicking on the **Settings** button**.**

Click on the **Application** button and select **Print** to print the displayed exams immediately or alternatively select the **Print Preview** to adjust titles and margins and view output before printing (see the Medmont Studio documentation for more detail).

Printing to a color printer provides a concise summary of the exam (see Figure 39).

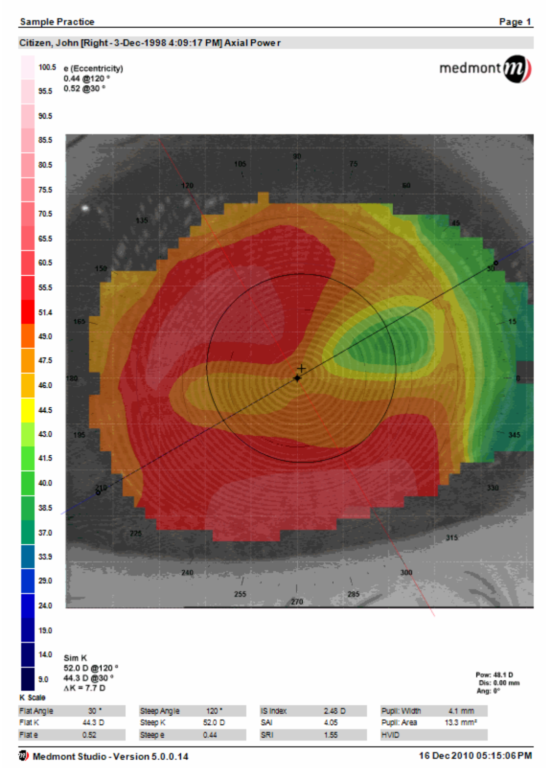



Figure 39. Standard exam printout in Print Preview.

## Exporting the Analysis

The E300 software provides the facility to dump raw topography data for the selected exam to a set of text files. This data can then be imported and manipulated by external software and tools.

First select the exam analysis to export. Then click the **Analysis** > **Data** > **Export** button . Specify the “root” name and location of the files to create. Typically the file name is based on the patient’s name, for example “JohnSmyth”. The following files are created:

> ***Filename.axl*** – axial curvature data (in mm)
>
> ***Filename.tgl*** – tangential curvature data (in mm)
>
> ***Filename.hgt*** – corneal height data (in mm)
>
> ***Filename.dst*** – radial distance data (in mm)

***Filename.slp*** – corneal slope data

Each line of the file contains the data for a single spoke (centred at the keratometric axes) with data points for each ring. Missing data is indicated by zero values. There are 300 spokes each with 32 rings.

# 8. Fitting Contact Lenses

The E300 software provides a simulated fluorescein display for evaluating the fit of RGP contact lenses (see Figure 40). Note the T and N letters denote the Temporal and Nasal orientation of the lens.


The fluorescein display is a simulation and should only be used as a guide to the expected fit. Simulated fitting of lenses larger than the captured data area is based on extrapolated data and may therefore be less accurate. A trial lens fitting should always be performed to confirm the simulation results.


Figure 40. Simulated Fluorescein Display

## Creating a new Contact Lens

Before proceeding with contact lens fitting you should have captured exams for both eyes of the patient (see *Capturing Patient Exams* on page 17).

Select the Patient Exam on the Explorer pane and click on the **Home > New Exam > Contact Lens** button. This displays the Contact Lens Design dialog shown in Figure 42.

## Restricting the Available Designs

If required you can restrict the set of available lens designs to better suit your practice. Click on **Manufacturers** within Contact Lens Design dialog to display the lens design selection dialog shown in Figure 41. Check or uncheck the manufacturers as required.

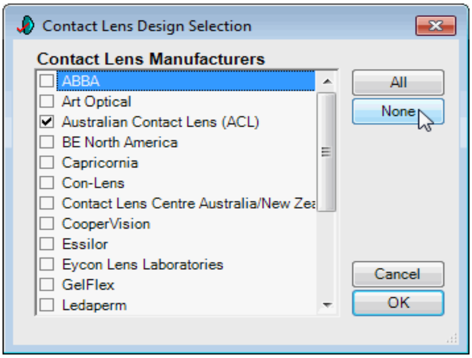



Figure 41. Contact Lens design selection dialog.

## Selecting the Lens Design

The Contact Lens Design dialog (see Figure 42) allows you to select the lens design to use. When a new design is selected from the drop-down selection box the recommended parameters for the design are automatically calculated based on the eye geometry. The simulated fluorescein pattern is computed and displayed.

The dialog also allows you to specify the manifest refraction that the software uses to calculate the required contact lens power. For a new lens this will be set by default to the current refraction values for the patient from the Patient Management system.

The dialog is displayed when creating a new contact lens. You can also use it to change the design or refraction for an existing contact lens by clicking on the **Display** > **Design** > **Change** button.

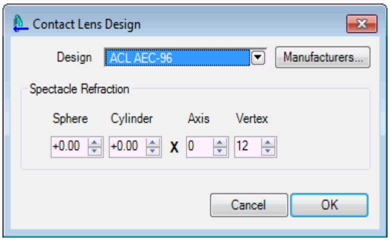



Figure 42. Contact Lens Design dialog

Several of the lens designs will display a lens designer dialog box to allow manipulation of design settings specific to that design.

## Editing the Lens Design

Clicking on the **Display** > **Design** > **Edit** button will display the contact Lens Designer dialog. This is normally displayed automatically when you create a new contact lens. The parameters that are displayed and can be changed in this dialog depend on the selected lens design. An example for an ACL TriCurve is shown in Figure 43. Typically the controls allow you to change parameters such as the lens diameter, base optic curve radius and peripheral curve parameters.

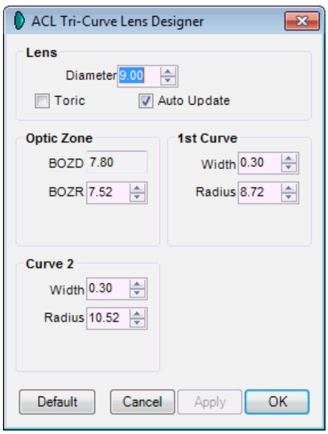



Figure 43. ACL TriCurve contact lens designer dialog.

Enter values in the numeric text boxes by clicking the spin-buttons or using the keyboard (see *Software Conventions* on page 5).

For some lens designs, changing values may cause other values to be recalculated to match. For instance, when the base optic radius is changed the peripheral curve parameters are generally automatically updated. For the lens design dialogs where this occurs, the automatically generated values can be overridden by changing them manually, and you can uncheck the ***Auto Update*** option if you do not want the peripheral curves to be updated when you change the base curve or diameter of the lens.

Click on the ***Apply*** button to display the simulated fluorescein pattern for the new parameters. The ***Defaults*** button restores the default settings for contact lens designs based on the eye geometry.

## Moving the Contact Lens

The contact lens can be moved over the eye to determine how the fit varies as the lens moves. Select the contact lens by clicking on the outside border or central dot. You may need to move the section indicator first. When selected, the lens border and central dot are displayed in red. Hold the mouse button down while dragging the lens to move it. When you release the mouse button the lens is left at the current location and a new simulated fluorescein pattern is generated.

## Contact Lens Parameters

The software calculates the required lens power (**Calculated Lens Power**) by adjusting the manifest refraction to take into consideration the vertex distance for the refraction and any resultant tear film power.

The predicted residual astigmatism (**Residual Astigmatism**) is calculated by comparing the corneal and manifest refraction astigmatism.

These values and other design parameters are displayed in the **Lens Parameters** panel. The visibility of the Lens Parameters panel is controlled by the **Display > Show/Hide > Lens Parameters** checkbox..

## Contact View Settings

A number of parameters specific to the lens design are available on the **Display** > **Show Hide** ribbon bar group as shown in Figure 44.


Figure 44. Contact Lens View Settings Dialog.

## Printing the Contact Lens Design

First select the contact lens or lenses that you wish to print by selecting them in the Explorer pane. Select the printer to print to and paper size by navigating to **Application Button > Print**, then click the **Settings** button. To print immediately, navigate to **Application Button > Print**, then click **OK**. Alternatively, navigate to **Application Button > Print Preview** to adjust titles and margins and view output before printing. A typical fluorescein print is shown in Figure 45.

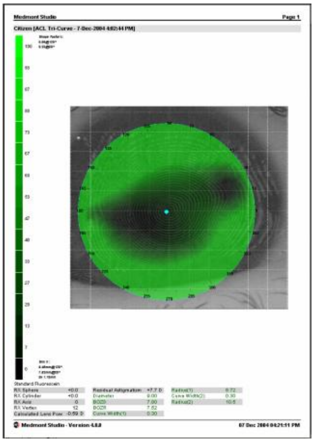


Figure 45. Example fluorescein printout in Print Preview.

# 9. Managing Exams and Calibrations

This section describes general housekeeping procedures for managing various aspects of the E300 database.

## Editing Exam Details

Select the Patient Exam entry in the Explorer pane and select Details Exam View mode (see *Setting the Exam View Mode* on page 24). The software displays the Patient Exam details (see Figure 14).

Enter or change any of the details. Any changes will enable a ***Cancel*** and ***Save*** button. Press ***Save*** to save your changes. The ***Cancel*** button discards any changes.

### Moving an Exam to a Different Patient

If you accidentally capture an exam against the wrong patient it is possible to transfer the exam to another patient. Click on the ***Change*** button and enter the details for the correct patient. Click ***OK*** to make the transfer.

### Changing the Calibration Used for an Exam

The software sets the calibration used to analyse a Patient Exam when the Exam is captured. It is possible to change this using the Calibration drop-down box. Usually the only reason for doing this would be if you discovered that the instrument has gone out of calibration (see *Calibrating the E300* on page 65). Once you have re-calibrated the instrument select the Patient Exam that you wish re-analyse, and select the new calibration using the Calibration drop-down box. When you next view the Patient Exams in Map, Combination or Difference View Mode they will be analysed using the new calibration.

### Categories

Categories are user-defined words or phrases that describe the nature of the examination. You can add, delete and change the available categories (see the Medmont Studio user manual). Categories are displayed in the Details view which can be accessed by selecting the **Details** button  from above the patient tree (see Figure 46).

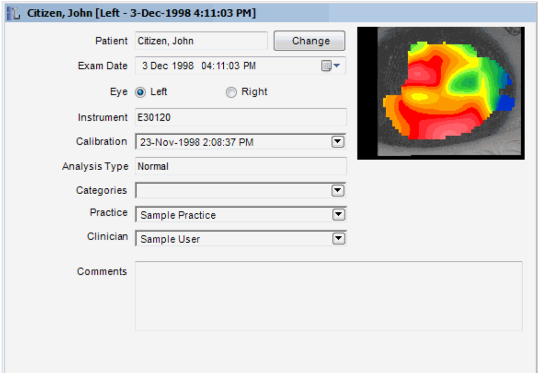



Figure 46. Exam Details dialog.

## Deleting Exams, Prescriptions and Calibrations

You can delete exams, prescriptions and calibrations but keep the following in mind:

- Deleting a calibration also deletes all of its calibration tests.
- You cannot delete a calibration that is used by a patient exam.

| In general it is not a good idea to delete calibrations. |
|---|

Select the item(s) to be deleted in the Explorer pane. Then click on **Home** > **Exam** > **Delete**.

# 10. Calibrating the E300

The accuracy and repeatability of exam results is dependent on ensuring that the E300 is correctly calibrated. The instrument is supplied with a calibration object, which is calibrated to the National Standard.


Handle and maintain this object with care! Do not touch, scratch or dent the object surface; it is a delicate optical device.

The calibration object should be verified and re-calibrated every two years as stated on the calibration label, either by Medmont or a Certified Measuring Laboratory. If any surface defects are identified the object must be replaced to ensure the best calibration result. You should check the calibration of the instrument:

- After installation or moving the system to another location.
- On a monthly basis.

To calibrate the installed instrument, navigate to **Configure** > **E300** > **Instrument Setup**. Then from the E300 Instruments window, click on the installed instrument and click **Calibrate** to run the Calibration Wizard, which allows you to check the current calibration and optionally recalibrate the instrument. The following sections describe the Calibration Wizard steps.

## Choosing the Video Source

The first step of the calibration wizard is to specify the device used to capture video from the E300 topographer (see Figure 47). The first option is **Leutron PCI Capture Card**, choose this if your topographer connects to a PCI card using a long, flat D shaped connector. The second option is **USB Video Converter Box**, choose this if your topographer connects to a grey box using a round 8-pin connector which then connects to the PC with a USB cable. If you are upgrading from Leutron to USB now is the time to change the Video Source device, doing so requires a full factory calibration which may take several hours to complete.

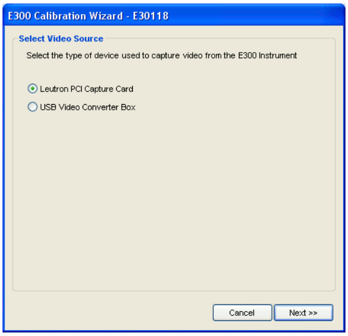



Figure 47. Choosing Video Source

## Capturing Calibration Images

The Calibration Wizard captures five separate images of the calibration object at different locations within the instrument's working range (see Figure 48). It analyses these images to measure the error in the current calibration.

To start, mount the calibration object in the E300 chin rest. There is a slot beneath the top rail of the chin rest and a 4mm hole facing the E300. Hold the calibration object with the ball facing the E300, and slide the tab with the threaded hole into this slot from beneath. While holding it in position, insert the retaining screw with the knurled knob into the hole and screw it into the tab. Alignment is not important and only tighten finger-tight.

The E300 joystick allows positioning in three dimensions. Move the joystick in the desired direction for movement left and right and for closer to or further away. Rotate the joystick knob for movement up and down, clockwise to raise, anti-clockwise to lower.

Position the instrument to align the centre of the rings with the central cross hair and the focussing bar over the central horizontal cross hair. When the instrument is properly positioned the wizard will automatically capture the image. Press the ***Next*** button and repeat the process to capture each of the five images.

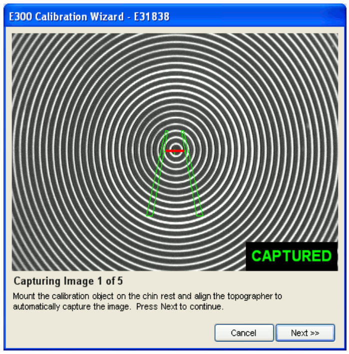



Figure 48. Capturing Calibration Images

## Checking the Current Calibration

When the five images have been captured the wizard calculates the error in the current calibration and displays it (see Figure 49). This screen allows you to choose to recalibrate the instrument or continue using the current calibration. The wizard will recommend a course of action depending on the degree of error in the current calibration.

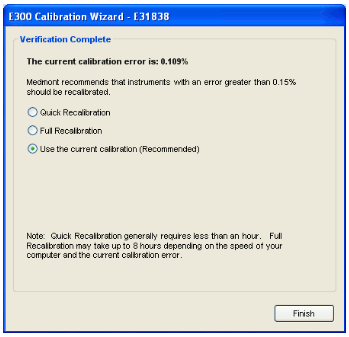



Figure 49. Verifying the Current Calibration

## Recalibrating the Instrument

If you elect to recalibrate the instrument the Calibration Wizard will run the calibration process. It displays the current status of the calibration (see Figure 50). If you select the *Quick Recalibration* option then the calibration will stop automatically once the software is unable to reduce the error any further, over a number of consecutive calibration cycles. If you select *Full Recalibration* then the calibration will complete the maximum number of calibration cycles. *Full Recalibration* is generally only required for new instruments (done at the factory) or for instruments where the capture device or other physical hardware has been changed.

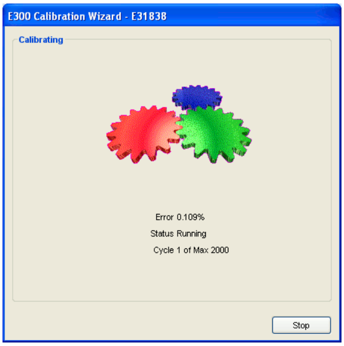



Figure 50. Recalibrating the Instrument

Calibration of the E300 involves analysing and adjusting over 80 software parameters to match the exact physical dimensions of the instrument. Consequently, depending on the speed of the PC, *Full Recalibration* may take several hours. A *Quick Recalibration* usually can be completed in under an hour and generally takes between 10 and 15 minutes. The calibration process can be stopped at any stage and resumed later.

At the completion of calibration the verification screen is displayed again and the software recommends whether further calibration is required based on the calibration error.

# 11. Menu and Icon Reference

The E300 software component adds the following types of icons to the Medmont Studio Explorer pane:

E300 Exam – displayed under Patient nodes in the Tree and E300 panes.

Idealized Eye – displayed under Patient nodes in the Tree and E300 panes. This represents an idealized symmetrical, toric ellipsoidal surface derived from one or more actual eye exams.

Contact Lens – displayed under Patient Exam or Idealized Eye nodes in the Tree pane.

## View Items

The E300 component adds the following items above the patient tree in Medmont Studio (note: the items are only visible when an appropriate item is selected in the Explorer pane):

**Details –** displays the details for the selected E300 Exam and allows you to edit them (see *Editing Exam Details* on page 63).

**Map –** displays a color contour map or 3D perspective map of up to four selected E300 Exams (see *Setting the Exam View Mode* on page 24).

**Combination –** displays four different views of the selected E300 Exam (see *Setting the Exam View Mode* on page 24).

**Compare –** displays a contour map of the difference between two selected E300 (see *Setting the Exam View Mode* on page 24).

## Home Tab Items

The E300 component activates the following menu items for the Medmont Studio Home tab:

**Corneal Topography** – displays the E300 Capture screen.

**Contact Lens –** creates a new Contact Lens for the selected Patient. (see *Fitting Contact Lenses* on page 58).

## Configure Tab Items

The E300 component activates the following items in the Medmont Studio Configure tab:

**Instrument Setup** – Opens the E300 instruments window which allows you to setup, delete and calibrate E300 instruments

**Calibrate Instrument –** allows you to check the accuracy of the current calibration and recalibrate if required (see *Calibrating the E300* on page 65).

**System Settings** – allows you to configure to adjust the Eccentricity and Shape Factors, the height and Wavefront errors which affects the attribute values.

## Analysis Tab Items

The Analysis tab is added by the E300 component. It is only displayed when a Patient Exam is selected:

**Reset –** clears the analysis of the selected E300 Exams. This forces the software to re-analyse the selected exams.

**Export –** creates a set of text files containing raw E300 Analysis data for the selected E300 Exam (see *Exporting the Analysis* on page 56).

**Details –** displays numerical readouts for apical curvature, sagittal height and shape factor, etc. calculated at a specified meridian and chord diameter for the selected E300 exams (see *Displaying Analysis Details* on page 44).

**Ideal Eye –** creates an idealized symmetric, toric ellipsoidal surface based on the average values of the currently selected exams.

**Edit** – Allows you to edit the E300 exam to highlight and remove artefacts.

**Remove Selected** – Removes a point(s) that have been highlighted as an artefact for removal.

## Display Tab Items

The Display tab is added when a graphical E300 view is selected or taking an E300 exam (see *Setting the Exam View Mode*).


**Reset –** resets the zoom and pan to the default settings for the displayed view.


**Zoom In** – zooms in on the displayed views.


**Zoom Out** – zooms outwards on the displayed views.


**Pan Left** – pan to the left of the displayed views.


**Pan Right** – pan to the right of the displayed views.


**Pan Up** – pan towards the top of the displayed views.


**Pan Down** – pan towards the bottom of the displayed views.


**Select –** set the cursor mode of the displayed views to enable selection of the section indicator and cursor readout.


**Pan –** set the cursor mode of the displayed views to enable interactive panning using the mouse.


**Zoom –** set the cursor mode of the displayed views to enable zooming using the mouse.


**Change –** displays the contact lens design dialog, and allows you to select the contact lens design and alter the manifest refraction (only available when a contact lens has been selected).


**Edit –** displays the contact lens designer for the selected lens design, and allows you to edit the lens parameters (only available when a contact lens has been selected).


**Planar –** image data is displayed as a plan color map.


**Perspective** – image data is display a color map overlayed on a perspective 3D view of the eye.


**Reset** – Resets the Display tab options back to their default settings.

**Map Type** – a drop down list box that allows you to select the type of image data to display.

**Data Settings** – Map options when the Elevation, Height – Zernike Fit and Wavefront Error: Zernike Fit has been selected from the Map Type drop-down list.

**Colour Map Opacity (%)** – Set the level of transparency for the Colour Map.

**Perspective Scaling** – A spin control allows you to display 3D Perspective views with enhanced distortion.

**Sim K units** – Allows the user to select the units of measurement for the resulting data in both the top and bottom data blocks when Zoned K or Sim K have been selected. Options are: mm (millimetres), D (Diopters), or Auto K, which will automatically select the best unit of measurement based on the chosen map type.

**Image** – Toggles on or off the raw video image, leaving just the colour map.

**Colour Map** – Toggles on or off the colour map, leaving just the raw video image.

**Numeric Data** – Toggles on or off the display of numeric data at specific points on each 30 degree spoke. The data displayed at each point will depend on the chosen map type.

**Cartesian Grid** – Toggles on or off a one millimetre rectangular grid, centred on the keratoscope axes, overlaying on the colour map.

**Polar Grid** – Toggles on or off reference ring, centred on the keratoscope axis, overlaying the colour map.

**Keratometrics** – Toggles on and off the display of the Keratometrics. The steep axis is calculated as the spoke with the highest average axial power whilst the flat axis is always set at 90 degrees from the steep axis.

**Readout** – Toggles on or off a readout marker (white cross) relative to the keratoscope axis. The data values at that location are displayed in the bottom right hand corner of the exam.

**Annotations** – Toggles on or off the Annotations stored within the exam.

**Cross Section** – Toggles on or off a cross-section of the displayed data in a tabbed window below the colour map. A white indicator line is displayed over the colour map to indicate the source of the cross section.

**Attributes** – Toggles on or off the Attributes panel which is displayed below the exam.

**Top** – Drop-down controls for the top left hand side data block (see *Text Data Blocks* on page 33).

**Bottom** – Drop-down controls for the bottom left hand side data block (see *Text Data Blocks* on page 33).

## Edit Tab Items

The Edit tab is added by the E300 component. It is only displayed when a Patient Exam is selected:

**Text –** add a text annotation to the image.

**Callout –** add a callout annotation to the image.

**Ruler** – create ruler annotations; used to measure distances on the image.

**Circle –** create circle annotations.

**Ellipse** – create ellipse annotations.

**Rectangle –** create rectangle annotations

**Square –** create square annotations.

**Polygon –** create polygon area annotations.

**Curved –** create curved area annotations.

**Freehand –** create freehand area annotations.

**Edit –** edit the selected annotation.

**Delete –** delete the selected annotation.

**Save** – save the selected annotations.

**Undo** – undo the most recent annotation.

**Pupil –** allows you re-compute the pupil

**Iris –** allows you to define the iris

# 12. Glossary of Terms

**Analysis**: The process by which the Placido rings - or segments thereof - are identified on the image, and from their distortions as much of the corneal surface as possible is reconstructed.

**Calibrate**: The process in which an optimal **calibration** is obtained, such that the overall error in reconstructing the surfaces for the **calibration images** is minimized.

**Calibration**: A set of parameters used during the analysis of an image to compensate for small variations in the manufacture of the instrument.

**Calibration object**: A small reflective ball of known radius

**Calibration images**: A set of (currently 5) images of a **Calibration object**.

**Categories**: A set of clinician provided descriptions that may be used to describe a particular eye. Examples would be: “pre-op”, “post-op”, “corneal graft”.

**Color key**: An on-screen column of colors, with their corresponding value listed beside each color.

**Color scale**: A sequence of colors used to color a representation of a surface.

**Elevation**: The difference between the height and either a best-fit or user-specified sphere.

***e***: Eccentricity of an ellipse on a plane slicing through the **reference axis** and a specified axis on the surface. The ellipse is fitted to the central point and a specified point on the surface axis. Usually the **steep axis** and **flat axis** are used to give a pair of *e* values.

**Flat axis**: The axis orthogonal to the **steep axis**.

**Idealized eye**: A symmetric, toric, ellipsoidal surface based on the average values of one or more surfaces.

**Inferior/Superior (IS) index**: The **IS** is the difference (measured in diopters) between the average inferior power and the average superior power.

**Installed instrument**: The instrument (specified by its serial number) that the software expects to use for image capture.

**Keratometric power**: For a given line through the centre of the surface, this is the axial power at the point on the line where a keratometer would take its measurement (maximized when the given line is the **steep axis**).

**Power maps**: Axial, tangential and refractive power representations of the surface, measured in diopters.

**Reference axis**: On the physical instrument, the longitudinal axis passing through the centre of all the Placido rings. In the mathematical 3-dimensional space in which the surface is reconstructed, it is a line passing through the centre of the image, roughly orthogonal to the surface.

**Refraction**: Summary of the patient's current spectacle prescription. Consists of: *sphere*, *cylinder*, *axis* and *vertex*.

**Score**: An automatic percentage rating of the quality of an image. Three basic scores are computed for each image, measuring: the amount of *movement*, how well *centered* the eye is, and the *distance* from the eye to the ideal capture plane. A total score, which is the product of the three basic scores, is also computed.

**Sim-Ks**: Simulated keratometer values, measured along the **steep axis** and the **flat axis** (see **keratometric power**).

**Steep Axis**: The axis along which **keratometric power** is maximized.

**Surface Asymmetry Index (SAI)**: The SAI is the centrally weighted average of the difference in power between corresponding points at the same chord, 180 degrees apart on the eyes surface.

The weighting value used is:

$$Weight = \frac{1}{R^r}$$

Where; $R$ = radial distance from the keratometer axis

**Surface Regularity Index (SRI):** This is a calculation of amount of local variation in the power of the eye within the average virtual pupil. The predicted power at a point is calculated as the average of the values of its rectilinear neighbours. The difference between the predicted power and the actual power is averaged over the central 4mm chord area.

The SRI is then given by:

$$SRI = \log(ZERO\_POINT + SCALING\_FACTOR \times avg(abs(PredictedP - ActualP)))$$

Where; *PredictedP* = Predicted Tangential Power (based on the average power of the rectilinear neighbours)

*Actual P* = Actual Tangential Power

*SCALING_FACTOR* = 10.0

*ZERO_POINT* = 0.90

***Note:*** SCALING_FACTOR and ZERO_POINT values are chosen to given equivalence with the original TMS SRI values.

**Tear-Film Clearance (TFC)**: The distance between the surface of the eye and the contact lens at a point.

# 13. Cleaning, Maintenance and Service

To maintain the life of the components and the accuracy of the instrument, regular maintenance is required in the form of lubrication and cleaning.

## Routine Hygiene and Cleaning

All surfaces coming in contact with patients need regular disinfecting. Standard instrument grade disinfectant diluted with 50% water may be used on all external surfaces. Wipe surfaces with a damp cloth only to avoid liquid entering delicate parts and optics. Do not use strong oxidising agents or solvents as they could damage surface coatings. Do not use any aerosols or sprays that could contaminate the optics. Use soft non-abrasive cloth only. Special care of the inside of the cone is required, and is described in the section below.

## Cleaning of contaminated Optics

The following optics are externally accessible and subject to contamination from dust, residues from evaporated liquids, body acids and fats, and makeup.

- Cone surface.
- Imaging lens front surface.
- Profile illumination window (on RH channel just inside cone edge).
- Profile image window (on LH channel inside cone edge).

Internal optical surfaces are not accessible without disassembly. Do not attempt to disassemble or turn any of the sealed mounting screws, as the alignment of the optics and the calibration may be altered considerably. Do not put any objects into the cone other than those listed.

Recommended cleaning materials:

- Lint free lens paper.
- Cotton applicators.
- Grease absorbing micro fibre cleaning cloth (e.g. Luminex).
- Non-smear optics cleaner.

The cone assembly is made of polymer products. This means the cone is sensitive to mechanical surface damage (scratches, dents) and may not be chemically resistant to certain solvents.

Do not use any abrasive cloth or strong organic solvents like acetone.

The image lens is positioned near the apex of the cone and difficult to access. Unless the optical performance of the lens is noticeably affected we do not recommend approaching the lens. Dust on this surface is not visible on the image. Its effect is a lowering of image brightness and overall resolution (not local blurs) only.

The profile windows are 2 x 2 mm in size. To reach the corners of these windows form the tip of a cotton applicator with tweezers to a pointed rectangular shape and wet slightly with optics cleaner.

The narrow end of the cone can easily be reached with the cotton applicators. For the entrance area cloth or cotton gives a good result.

## Calibration Object

The calibration object has a delicate optical surface. After use clean with isopropanol and a lint-free cloth to prevent acid corrosion from fingerprints. Use the same technique to remove any contamination prior to using the object again.

## Lubrication

All parts except the exposed horizontal shaft are permanently lubricated and do not require any additional lubricant. The horizontal shaft should be cleaned from dust and old oil residues and oiled every few months. This also protects the shaft from corrosion. The oil used should be acid free fine instrument oil, e.g. sewing machine oil. Apply only a fine film with a lint free cloth.

## Service

For servicing and repair, please contact your local agent to advice on suitable and qualified providers. Medmont will make available on request to the service provider circuit diagrams, components, parts lists and instructions etc. as required.

## Troubleshooting

The following guide is an aid for the user to help identify, describe and remove certain errors.

| Problem | Comment | Action |
|---|---|---|
| No video image | 12V indicator light is OFF | Instrument ON/OFF switch on?<br>Check power adaptor is fully plugged in.<br>Return back to supplier for repair. |
| No video image | USB power indicator is OFF | Ensure USB plug is properly connected at both the PC and converter box ends.<br>Return back to supplier for repair. |
| No video image | Error indicator is flashing | Disconnect and reconnect the USB connection to perform system reset.<br>Return back to supplier for repair. |
| No video image | **MEDMONT E300 USB** device not displayed in Device Manger | Instrument ON/OFF switch on?<br>Check status lights are showing correct power connection.<br>Check USB port is at least USB 2.0 or higher.<br>Check Windows XP SP2 or higher is installed.<br>Reboot the computer to re-initialise the USB port.<br>Return back to supplier for repair. |
| No cone illumination | Illumination only comes on for a few seconds, when computer boots up, or when in Capture mode. | Instrument ON/OFF switch on?<br>Check power adaptor and D-plug to frame grabber are not loose<br>Check frame grabber card is firmly in PCI slot |

| | | |
|---|---|---|
| Distance bar in capture window not working, oversensitive or jumping | Blue LED is normally always on when instrument ON/OFF button is on. | Is bright light source present, which contaminates profile signal?<br>If yes: Remove light source, or reposition instrument.<br>If no: Check RH channel from front (look in sideways into small rectangular opening). Is blue light on?<br>*If yes: Has instrument been subjected to excessive shock, vibration or impact?*<br>If yes: check calibration and recalibrate if necessary. |
| Instrument does not calibrate | Possible reasons:<br>One or more images taken out of distance range<br>One or more images too far off centre<br>One or more of the calibration balls not clean<br>Profile optics misaligned<br>Dirt on profile optics<br>Too much stray light in image<br>Too much movement in image<br>Illumination defect | Identify problem, re-capture affected images if applicable and recalibrate |

# 14. Specifications

| | |
|---|---|
| Model | E300 |
| Type/Variant | USB |
| Product | Life8 years (software previous version of current operating system |
| Method of measurement: | Placido |
| Coverage: | Diameter 0.25-11 mm |
| Field of View: | 11.5mmH x 11mmV |
| Illumination: | Red 660nm<br>Green 565 nm<br>Blue 430nm<br>Luminance < 50 cd/$m^2$ |
| Power range: | 10-100 Diopters |
| Number of Rings: | 32 |
| Measurement Points | 9,600 |
| Analysed Points | 102,000 |
| Repeatability: | < 0.1 Diopters |
| Calibration Object | R8.000mm +/-0.001mm |
| Footprint: | Width: 320mm<br>Depth: 400mm |
| Eye level adjustable on unit: | 352 – 382mm |
| Weight: | 5.5kg (without table, chinrest) |
| Power requirements: | 100 – 240 V AC 10 VA (PC not included) |
| | 12 VDC, 6W via E300 USB Converter |
| PC and mains powered peripherals: | Compliance with EN/IEC60950<br>CISPR22 EN/IEC55022 |
| PC: | (See Medmont Studio Manual) |
| Printer: | Bubblejet/Laser<br>Color/ Monochrome |
| Back Up: | CDROM or DVD burner |

| | |
|---|---|
| Operating conditions: | +10° to +40°C<br>max 80% relative humidity |
| Isolation Transformer | Compliance with EN/IEC 60601-1<br>National electrical safety regulations |
| Transport/Storage Conditions: | -15° to +40°C<br>10% to 95% relative humidity<br>500 to 1060 hPa |

# 15. Representatives

The EU Authorised Representative:

*BiB Ophthalmic Instruments*
*Unit 8, The Orbital Centre, Cockerel Close*
*Gunnels Wood Road*
*Stevenage, Hertfordshire SG1 2NB*
*England*
*Tel: 0044 (0)1438 740823*
*Fax: 0044 (0)1438 356093*

Your Local Medmont Authorised Agent is: