$50 US

IOLMaster
A Practical Operation Guide

Get the best possible surgical outcomes for your patients – learn how to personalize your lens constants in Chapter 6!

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Introduction

"The eye is the light of the body; therefore if the eye is good, then the whole body will be full of light, but if the eye is bad, then the whole body will be full of darkness."

We are visual creatures. Our society, our technology, our entire way of life is centered around our ability to see. And if that ability is taken away from us, we will do everything we can to restore our sight.

One of the most common causes of vision loss is the cataract—a clouding of the natural lens that sits behind the pupil. Exposure to certain chemicals and medications can cause cataracts to develop. Ultraviolet light may speed up the process as well. Even poor health is thought to play a part. But ultimately anyone who lives long enough will develop a cataract, simply from the passing of time.

The first known technique to restore vision lost from a cataract has been traced back to India, where, in the 5th Century B.C., the surgeon Susruta performed an operation which later came to be called "couching." This technique involved literally pushing the cataract out of the way with a needle inserted into the eye. Though dangerous, couching would continue to be used as the primary form of treatment for cataracts for the next two thousand years.

In the 1740's, a French surgeon named Jacques Daviel performed the first known removal of the cataract from the eye—rather than simply pushing it aside like his predecessors—by physically "popping" the clouded lens out through the pupil in one solid piece.

While this new technique of cataract extraction was somewhat safer and more effective than couching, both operations left the patient severely far-sighted; distant objects appeared blurry, and nearby objects looked even worse! The use of thick glasses was required to provide the patient with usable vision after the operation.

Then in the 1940's, Harold Ridley successfully experimented with replacing the natural lens with a synthetic one, in order to provide the patient with functional vision even without glasses after the cataract surgery.

In the 1960's, Charles Kelman introduced the technique of phacoemulsification, in which an ultrasonic probe is inserted into the eye, essentially liquefying the lens and suctioning it out through a tube.

Ever since those early days, the surgical techniques and lens implant designs have continued to improve. Modern cataract surgery is typically performed as an outpatient procedure, often with no stitches and only anesthetic drops to numb the eye. Lens implants are now inserted in a rolled-up state and then unfold into their proper shape inside the eye itself. While the patient may be at the surgical site for a few hours, the actual removal of the cataract and insertion of the lens implant often takes less than ten minutes.

And yet, even with all of the advances in materials and techniques, there is always a question of which implanted lens strength to use in order to give the patient the best possible vision after surgery. For many years, we simply guessed at the implant power needed, based on the patient's glasses prescription. More recently, we utilized a combination of ultrasound A-scan devices and manual keratometry tools and a simple algebraic equation to estimate the implant power needed. While such methods were innovative for their time—and certainly a vast improvement over simply guessing—there is now available a much better way to acquire the measurements needed and to correctly choose the best lens power: The IOLMaster®.

This innovative technology is easy to use, provides an unprecedented degree of accuracy, and has a number of automatic fail-safes to help prevent mistakes and oversights. In the hands of a skilled operator, the IOLMaster can measure and calculate with such precision as to provide the absolute best lens power for each patient.

The ability to see is one of the greatest gifts we have been given. And with the help of this technology, you will be instrumental in restoring that gift to your cataract patients. So it is our hope that this guide will assist you in your initial and ongoing use of your new IOLMaster system.

☞ Note: This guide is based on version 5 of IOLMaster system software.

Special Thanks

We give special thanks to Mely Medel and Kathy Lewis for making this project possible, and as always, to our fellow Clinical Application Specialists for their support. We also thank those who reviewed the content of this guide and helped with editing, including Denny Dugal and Claus Dreher for their technical expertise, and Katy Murphy for her clinical expertise. In addition, Joel offers particular thanks to Tom McMillan, who first introduced him to the IOLMaster many years ago.

—Joel H. Emerson & Kelly Tompkins
Clinical Application Specialists,
Carl Zeiss Meditec

(1) The Eye and the IOLMaster

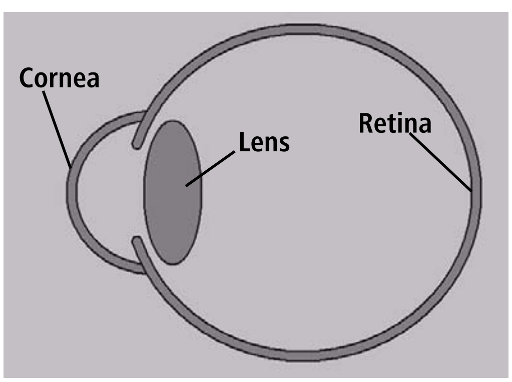
Welcome to the first chapter of your IOLMaster's practical operation guide. Soon enough, you will be reading about your new testing system and how to use it to measure your patients' eyes. But before we discuss how to go about using the IOLMaster, it's first important to understand what this system is testing—the human eye.

So, in this chapter, we'll discuss the various structures of the eye, how they assist in focusing light, and how cataracts and cataract surgery affect this ability to focus light.

Do you need to read this chapter in order to operate the IOLMaster? Well ... technically, no, you don't. You can follow the steps for testing the eye described in Chapter (4), but I strongly advise against skipping ahead. The human eye is a marvelous and complex organ, and understanding how it interacts with light—both before and after cataract surgery—will give you a better perspective and a more intuitive grasp of the IOLMaster.

Of course, if you are a doctor or a technician well-experienced in the anterior segment, what follows will undoubtedly be "old news" to you. But for those new to the ophthalmic field in general, or the anterior segment (that is, the front half of the eye) in particular, I believe you will find this chapter very useful.

Eyes and Optics 101



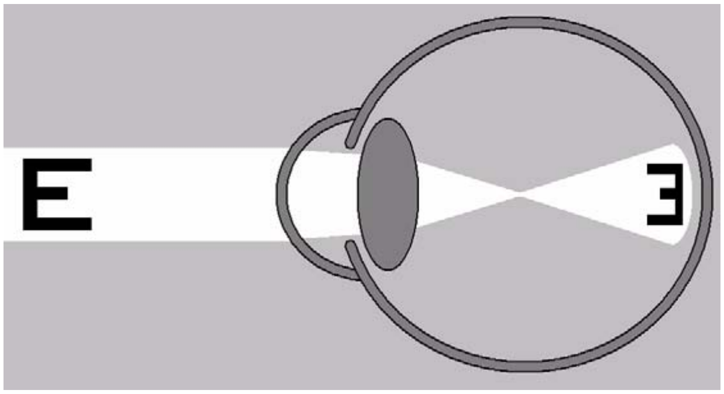
For the purposes of explaining how the eye works, we're going to simplify the anatomy and mechanisms of the eye and say that the eye is comprised of three main parts—the cornea, the crystalline lens, and the retina.

The crystalline lens is a clear structure about the size and shape of an M&M®, which sits just behind the dark pupil of the eye. Despite it's name, this lens is not made of crystal, but is transparent living tissue. It is made up of the nucleus which is the core of the lens, several cortical layers that surround the nucleus like the layers of an onion, and finally an outer capsule or "bag" that holds everything in place. The crystalline lens helps to focus images of light onto the retina, and can even change its shape in order to adjust this focus—or "accommodate"—when the various objects being viewed are at different distances from the eye.

The cornea is the clear dome on the front of the eye. Like the crystalline lens, the cornea helps to focus images of light onto the retina. Though it does not change shape like the crystalline lens, the cornea is the more powerful of the two, providing about two-thirds of the light-bending power of the eye.

The retina is the tissue at the back of the eye. The cornea and crystalline lens together focus images of light onto the retina, which then converts those images into nerve impulses for the brain to interpret.

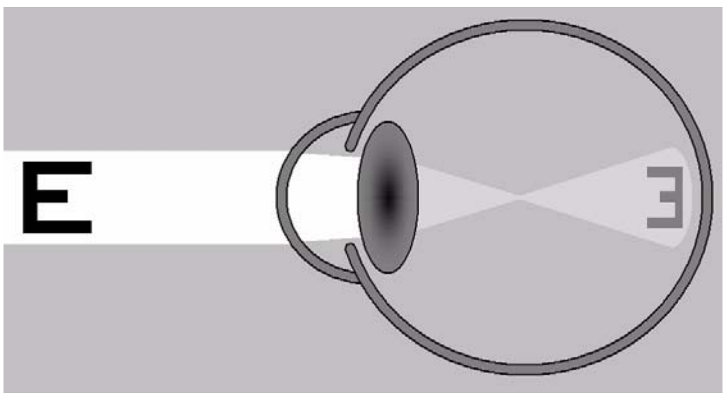
How the Lenses of the Eye Work



Light reflects off an object and comes to the eyes as parallel rays of light. The outward-curving (or "convex") clear dome of the cornea bends these rays of light inward into the eye. These converging rays of light then pass through the crystalline lens of the eye, which bends them inward even more sharply.

These rays cross over each other at a single spot called the "focal point", and then begin to spread out or diverge once again. When these diverging rays reach the retina, an image of light is projected there, as if on a movie screen at the theater. Because the image appears beyond the focal point, it is flipped around backwards and upside down. But the brain expects this, and automatically corrects the image's orientation when it is processing the nerve impulses it receives from the retina.

Cataracts



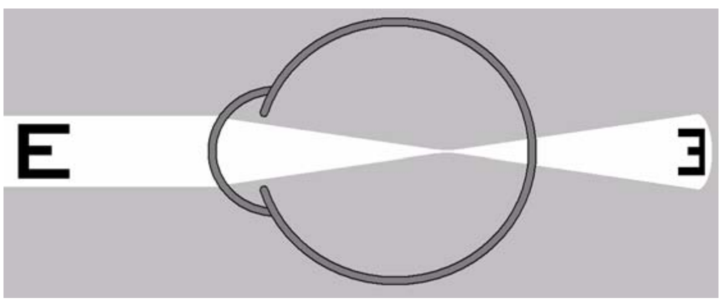
There are a number of patients who will come to your office under the impression that a cataract is a film or growth that forms over the cornea. It is a myth perpetuated by novels and movies in which blind characters have cloudy white corneas. While the cornea can certainly become cloudy over time, that is not a cataract.

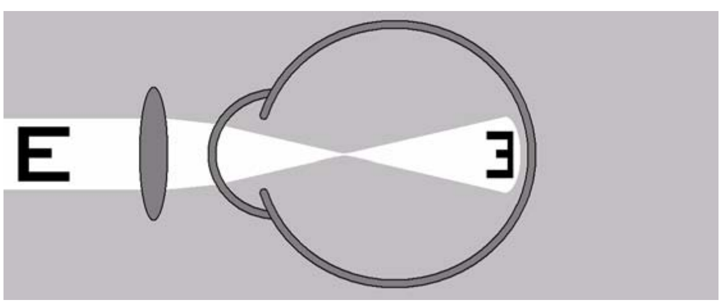
A cataract is just another name for the crystalline lens; it is what the lens is called after one or more of its layers have become clouded to the point that is affecting the patient's vision, or to the point that the doctor can clearly see it. A cataractous lens does not focus images of light as well as a clear crystalline lens would; by the time the images pass through the cataract, they may have become blurred or faded out. Conversely, some cataracts may also cause light to become scattered as it passes through the lens, causing sources of light to seem overly bright, with distracting streaks and glare.

Cataract Surgery

When cataract surgery is performed, the cataract is not merely peeled off of the lens; remember, the cataract and the lens actually are the same thing. Instead the lens—which has become the cataract—is removed from the eye.

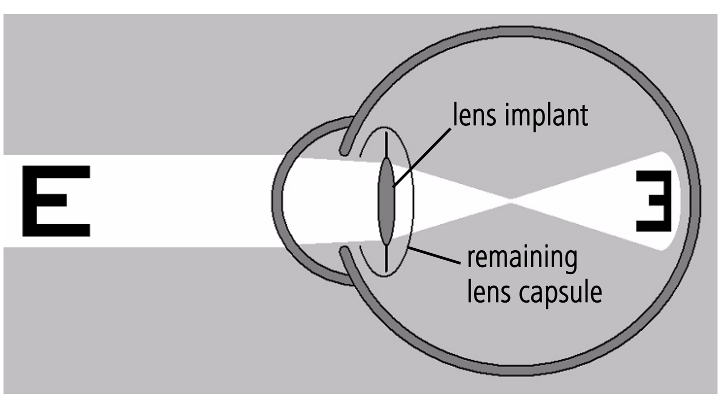
The good news is that more light can get into the eye now, since the cataract has been removed. The bad news is that without the crystalline lens, the eye is left with only the cornea to focus images of light.





Though the cornea is powerful, about twice as powerful as the crystalline lens, typically it is still not powerful enough by itself to focus images properly onto the retina. Thus, if the cataract is removed and nothing more is done, the patient is left aphakic—literally "without a lens." In most cases, aphakic eyes are farsighted; distant images are blurred, and nearby images are even worse. This is because the eye is shorter than the distance the cornea needs to focus the image by itself.

Placing a lens in front of the eye—either a thick lens in a pair of glasses, or a hard contact lens on the corneal surface—can help an aphakic eye to focus the image onto the retina.



Since the 1940's, though, there has been the option to implant a small synthetic lens inside the eye itself, which provides the patient clear vision with minimal need for glasses or contact lenses. Over the past six decades, techniques and technologies have improved continuously, yielding safer surgeries and better implants.

Today, in most cases, the front of the crystalline lens capsule is removed, along with the clouded contents of the lens, leaving the rest of the clear capsule intact to hold the implanted lens in place. Thus, the intraocular lens (or "IOL") sits more or less in the same position the natural lens once occupied.

How Strong Should the Implant Be?

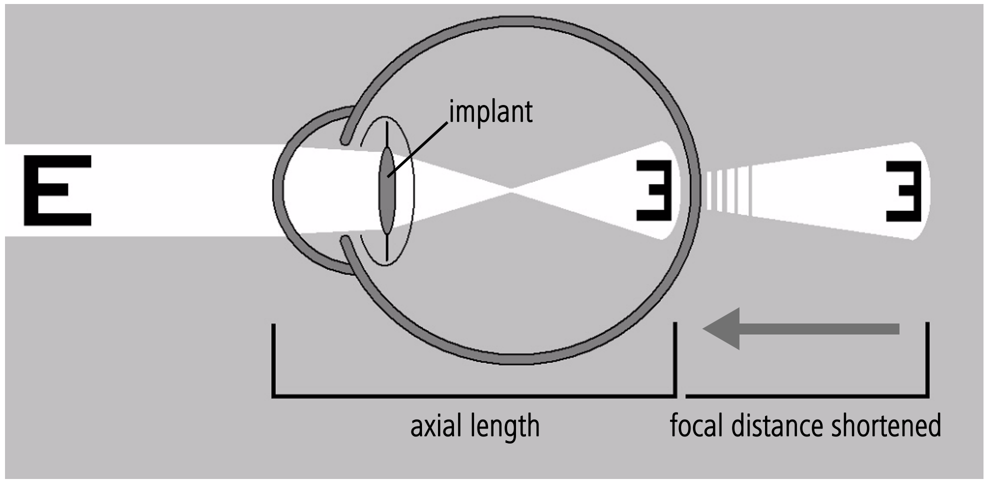
Now that we can implant a lens into the eye to replace the natural crystalline lens removed during cataract surgery, the question arises as to how strong the implanted lens should be. If it is too strong, the eye will be left nearsighted (only objects near the eye come into focus), but if it is not strong enough, the eye will be left farsighted (with distant objects blurred, and nearby objects even more blurred).

In the past, surgeons simply had to guess at the implant strength, based on the patient's prescription for glasses or contacts. Then along came the notion of measuring the length of the eye and the curvature of the cornea. How are those two measurements useful for choosing a lens implant strength? Good question…

By measuring the curvature of the cornea (these measurements are often called "K's," short for "keratometry"—literally, "corneal measurement"), we can determine the focal distance of the cornea—that is, the distance from the cornea to the image it's projecting on the other side. The steeper the cornea is, the shorter the distance is between the cornea and the image it is projecting. The flatter the cornea is, the longer the distance is between the cornea and the image it is projecting.

By measuring the length of the eye from the cornea to the retina (called the "axial length"), we know what the focal distance should be to get the image projected properly on the retina.

Typically once the crystalline lens is removed, the focal distance of the cornea is longer than the axial length of the eye. But by inserting a synthetic lens of the proper light-bending power, the overly-long focal distance can be shortened to match the actual length of the eye.



So, all the surgeon needs to do is insert a lens with enough light-bending power to shorten the focal distance to match the patient's axial length. Easy, right?

Well… as it turns out, it's not as easy as that. Because the lens implant and the cornea have space between them, and because each one sits at different distances from the retina, the equation becomes a bit more complex. That is why it is essential to obtain accurate measurements of both the axial length and the corneal curvature.

Before the invention of the IOLMaster, analysis of ultrasonic echoes (i.e., an "A-scan") was used to measure the axial length; and lining up and focusing images reflected off the cornea (i.e., "manual keratometry") was used to measure corneal curvature.

But with ultrasound, it is difficult to tell whether the scan is directed toward the macula—that is, toward the area of the retina that provides the patient with central vision. What's more, contact ultrasound requires actually touching the cornea with a probe, which presses the cornea in and artificially shortens the axial length. The alternative to contact ultrasound was immersion ultrasound. While this method certainly is more accurate than contact ultrasound, it requires the patient's lids to be held open while a plastic tube is placed over the eye and filled with saline. Not only is this uncomfortable for the patient, it still fails to provide certainty that the scan is being directed to the patient's central vision.

As for manual keratometry, this technique was designed for measuring the peripheral cornea for contact lens fittings. Peripheral corneal measurements do not necessarily provide the correct central corneal curvature—the curvature that most directly impacts the patient's vision. What's more, the measurement requires looking through a scope and turning various knobs to carefully align a series of shapes reflected from the patient's cornea. The accuracy of these measurements depends greatly on the examiner's skill, patience, and (ironically) his or her own clarity of vision.

Now we have the IOLMaster. It is quick, easy to use, and highly accurate. It measures the axial length along the eye's visual axis directly to the macula. It measures more centralized—and thus more relevant—corneal curvature. Its measurements are highly consistent and repeatable. And it has a number of built-in safety checks to help catch any mistakes the tester may make.

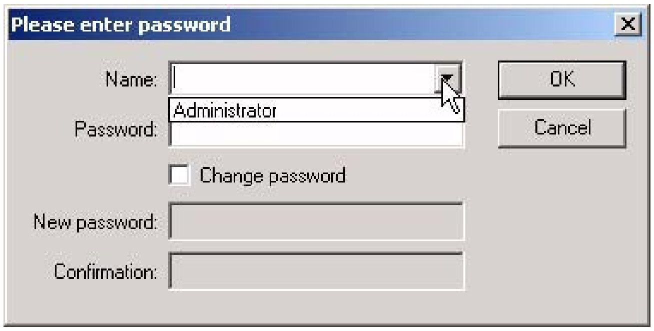
Now for what you've been waiting for…using the IOLMaster. Chapter (2) will deal with setting up your database of doctors and lenses, and Chapters (3) through (5) will deal with testing and calculating results.

(2) Entering Surgeon Names and Lenses

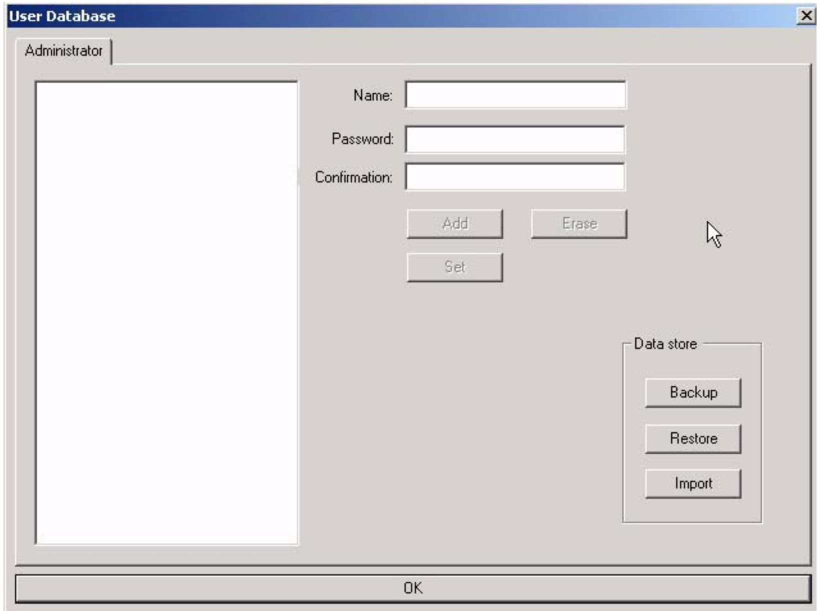
Okay, so you have an IOLMaster and are probably anxious to get started taking measurements. That time will come soon enough. Before taking any measurements, it is a good idea to set up the user database first. This chapter deals with that very subject.

Adding Surgeon Names

1. From the NEW PATIENT screen, select User Database from the Options menu (click Options > User Database). A dialog titled Please enter password appears.
2. Click the down-arrow by the Name field and select Administrator, as shown.



3. Leave the password blank, and click OK. The User Database dialog appears, showing the tab for the user you selected (Administrator).



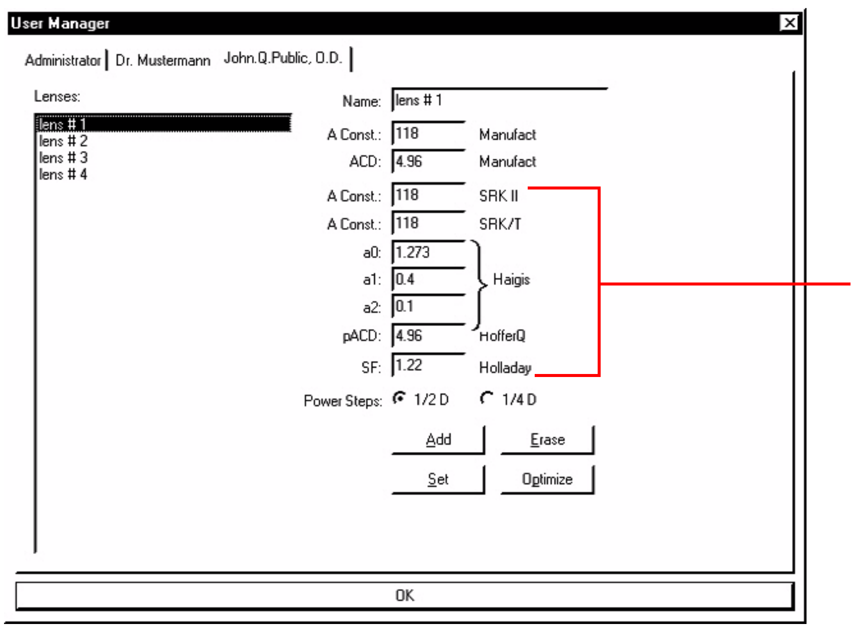
A list of surgeons (if you have entered any) appears on the left. To add a new surgeon to the list, just type his or her name *exactly as you want it to appear* on your lens calculation printouts in the Name field at right and click Add.

☞ **Important Note: At this stage, you may choose to assign a password to your administrator or your physician. Using passwords has pros and cons; ultimately, it is the physician's decision whether or not to use them. If you do assign a password to the administrator, be very careful not to forget it. If you forget the administrator's password, it is not an easy fix and will require a phone call to Carl Zeiss Meditec technical support.**

As you add new surgeons, their names will be listed alphabetically and each will one will have his or her own tab at the top of the screen. The tabs also appear alphabetically (except that the Administrator tab will always be at the far left).

4. After you have added a surgeon or surgeons (or if they're already there from before), click on their tab at the top of the screen.

You are now in that surgeon's personal lens file. A list of already entered lenses appears on the left, and a lot of empty fields on the right, unless one of the lenses is highlighted, as shown below.



These boxes are for the modified lens constants for the various formulas you will be using.

The fields to the right are empty when no lens is selected. In that case, they are for entering new lens data. These fields are highlighted above.

So, now you are in the surgeon files and are ready to add a lens. At this point, you will have to decide what lens constant information you will be inputting for each new lens.

Choosing A Lens Modification Option

Each lens comes with a manufacturer's A-constant, a number which can be used in various lens calculation formulas. But traditionally, this A-constant has been calculated assuming the use of contact ultrasound A-scans and manual corneal curvature measurements. Because the IOLMaster obtains measurements differently than the lens manufacturer's A-constant is designed for, modifications to this number need to be made. Typically, the IOLMaster measures the axial length measurement longer than contact ultrasound. The reason for this is that with contact ultrasound you are compressing the cornea, thereby shortening the axial length of the eye, but with the IOLMaster there is no contact with the eye and no artificial shortening of the axial length. This difference, if ignored, can result in undesired post-operative refractions.

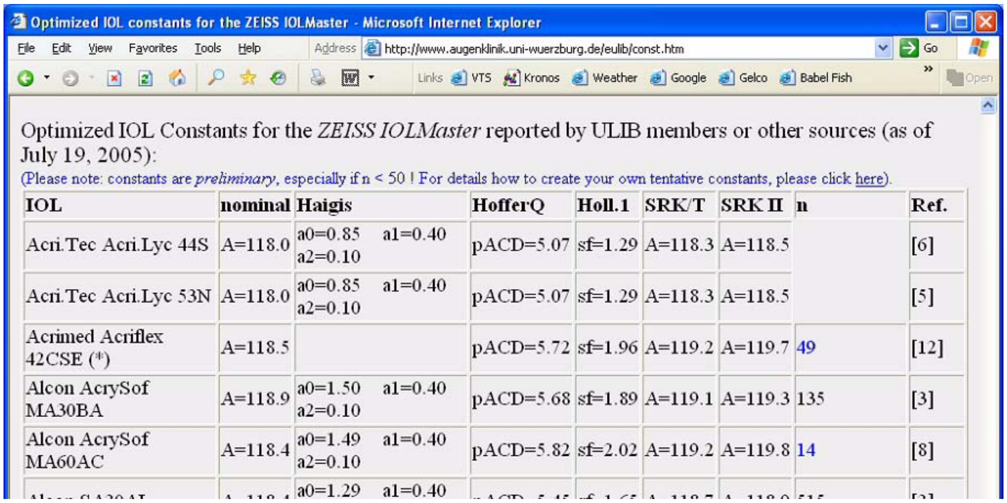
☞ **Important Note: If you are using immersion ultrasound for your axial length measurement method and have a lens constant that has already been adjusted for immersion measurements, there is a good chance that this lens constant will also work well with the IOLMaster. You can proceed to the** Adding A Lens **section on page** 2-5 **and input these numbers into the IOLMaster lens database.**

Below are a few of the most common options you have for modifying your lens constants. The surgeon should decide which method to use.

1. **Input lens constant information from the ULIB website.** The ULIB website contains optimized lens constant information for many lenses, provided by many surgeons all over the world. The ULIB website is maintained by Dr. Wolfgan Haigis, PhD. You can find this website by doing an internet search for "ULIB," or by following the link in the IOLMaster page on the Carl Zeiss Meditec website, which can be found at www.meditec.zeiss.com/iolmaster. You can then choose either to print out this list of optimized lens constants and manually enter the information into the IOLMaster, or download the information electronically to a CD or USB memory stick and import it directly into the IOLMaster. (For instructions, see the Downloading and Importing Lenses section on page 2-7.)

   This method has proven very useful for many surgeons and is probably the most commonly used method. However, every surgeon's technique is different—the A-constants that work for one doctor may not necessarily work for another.

You may notice that not every IOL in existence appears on the ULIB list. Only lenses used often enough by the ULIB group to have sufficient data for lens constant optimization make it onto the site. Below is an example of what the list of lenses on the ULIB website looks like.



Optimized IOL Constants for the *ZEISS IOLMaster* reported by ULIB members or other sources (as of July 19, 2005):
(Please note: constants are *preliminary*, especially if n < 50 ! For details how to create your own tentative constants, please click here).

IOL	nominal	Haigis	HofferQ	Holl.1	SRK/T	SRK II	n	Ref.
Acri.Tec Acri.Lyc 44S	A=118.0	a0=0.85 a1=0.40 a2=0.10	pACD=5.07	sf=1.29	A=118.3	A=118.5		[6]
Acri.Tec Acri.Lyc 53N	A=118.0	a0=0.85 a1=0.40 a2=0.10	pACD=5.07	sf=1.29	A=118.3	A=118.5		[5]
Acrimed Acriflex 42CSE (*)	A=118.5		pACD=5.72	sf=1.96	A=119.2	A=119.7	49	[12]
Alcon AcrySof MA30BA	A=118.9	a0=1.50 a1=0.40 a2=0.10	pACD=5.68	sf=1.89	A=119.1	A=119.3	135	[3]
Alcon AcrySof MA60AC	A=118.4	a0=1.49 a1=0.40 a2=0.10	pACD=5.82	sf=2.02	A=119.2	A=119.8	14	[8]

As you can see there is a lens constant/surgeon factor for each formula that is used on the IOLMaster Please note that the nominal value is the manufacturer's lens constant.

You can check Dr. Warren Hill's website (www.doctor-hill.com) for some additional optimized lens constants. He has some of these posted for you to get started, including some A/C IOL constants.

☞ **Important Note: Specific A-constants found on the ULIB website and Dr. Hill's website are not recommended by Carl Zeiss Meditec. You must examine them and determine if they are right for you.**

2. **Side by Side comparison study.** Measure the axial length on the IOLMaster. Then measure the axial length with contact ultrasound A-scan. You should measure 10 to 20 patients. Subtract the ultrasound's average axial length from the IOLMaster's average axial length. This will produce a very small number, probably around 0.10 or 0.15. Whatever this small number is, multiply it by 3. Then add this new number to your manufacturer's A-constant.

Example: Avg axial length on IOLMaster = 23.70 mm
Avg axial length on contact ultrasound = 23.60 mm
23.70 - 23.60 = 0.10
0.10 x 3 = 0.30

This is the number you will add to any manufacturer's A-constant. Now that you have this number, proceed to the Adding A Lens section on page 2-5.

This method is more customized and takes into account your own practice "compression factor".

3. **Speak to your lens representative, explain that you have an IOLMaster, and ask what numbers you should use.** Often lens manufacturers will have a recommended lens constant for use with the IOLMaster. Write this information down, and proceed to the Adding A Lens section on page 2-5.

Ultimately, whichever method you use, you are strongly encouraged to:

1. Do a comparison of your old method of measuring and calculating IOL power and the new method using the IOLMaster. Do not rely solely on calculations from the IOLMaster until you feel comfortable with the expected outcomes using the IOLMaster.
2. Perform an optimization of the lens constants, once you have enough post-operative data to do so. Chapter (6) deals with the optimization program on the IOLMaster.

Adding A Lens

Now that you have your lens constants, it's time to enter them into the IOLMaster. You will need to be in one of the surgeon's files for this.

1. First, type the name of the lens in the lens Name field at upper right.

2. Then type the appropriate number in the Manufacturer A-constant field (called **A const.: _____ Manufact**, located just below the lens name box). This number is based on the method of lens constant modification you have chosen.

3. Next, enter the appropriate lens constant numbers in the fields next to each formula. These numbers are based on the method of lens constant modification you have chosen.

- **For option 1, using the ULIB website lens constant information:** You can enter the information manually in each field from a printout, or import it directly into the IOLMaster from the media you have downloaded it to. When entering data manually, make sure you enter each number correctly in the field that corresponds to its formula. Remember the nominal number is what you put in the manufacturer's box; you do not need to enter a manufacturer's ACD. To import data directly, see the Downloading and Importing Lenses section on page 2-7.

- **For option 2, side by side comparison:** Just add whatever your result was—continuing the example above, you would add **0.3**—to whatever A-constant is printed on the lens box. Enter the resulting sum in the **Manufact.** field. Select **½ D** or **¼ D** (diopter) steps, and click **Add**. The instrument will automatically calculate and fill in the rest of the formula fields below. It is a good idea to go back and change the manufacturer's number to the correct manufacturer's lens constant and then click **Set**. This way, you will know at a glance whether the lens constant information was adjusted.

- For option 3, getting the information from the lens representative: Enter the information you are given in each field, including the fields for each formula. Select ½ D or ¼ D (diopter) steps, and click Add.

☞ **Important Note: Adding a new lens to one surgeon's file will not add it to every surgeon's file. You must add each surgeon's desired lenses under his or her own tab.**

Congratulations! You've just added a lens! This lens will now be available to be placed in one of the lens fields in the LENS CALCULATION screen.

Downloading and Importing Lenses

Downloading ULIB Lens Constant Data onto a CD-RW or Jump Drive

You will need to use another computer (not the IOLMaster) that is connected to the internet to access the User Group for Laser Interference Biometry (ULIB) website. This computer will need to have a CD burner or a free USB port with a compatible jump drive (also called thumb drives, memory sticks, USB sticks, etc.).

1. Put a blank CD-RW into the CD drive, or plug in your USB memory stick, so that the computer is ready and recognizes the drive.
2. Go the ULIB website:

   www.augenklinik.uni-wuerzburg.de/eulib/index.htm

   Links to it can be found on the IOLMaster page of the Carl Zeiss Meditec website (www.meditec.zeiss.com/iolmaster) and through Dr. Warren Hill's website (www.doctor-hill.com).
3. Near the bottom of the ULIB webpage, click the link to Download optimized IOL constants for the *Zeiss IOLMaster*.
4. On the next webpage that appears, explanatory paragraphs at the top conclude with the following sentence: "To proceed with the download, click here for the English version". Click where indicated—on the highlighted word "here"—and you will be taken to a Zeiss disclaimer page.
5. Read the page. At the bottom, select the checkbox next to "Yes, I've read the instructions for using the constants." When you do, a Start download option will appear. Click Start download.
6. At this point, the instructions may vary depending on your browser. For Internet Explorer, select the Save option. A dialog will prompt you to specify where to save the file. In the Save in: field, use the down-arrow to locate your

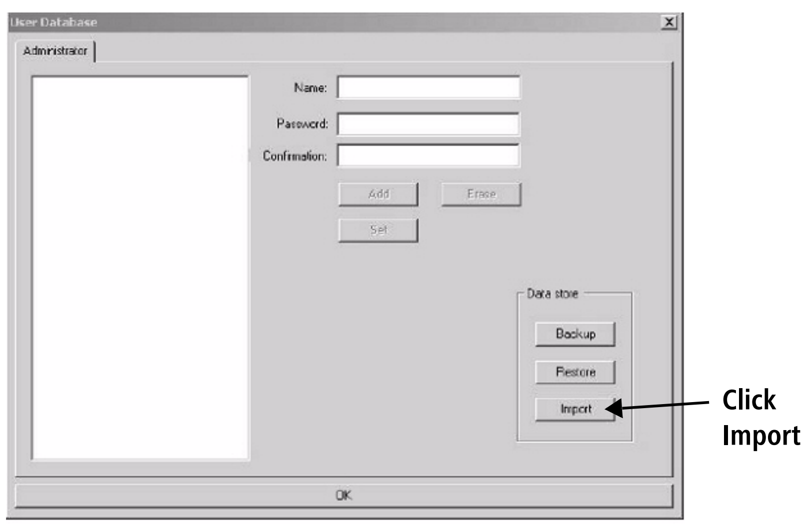
CD burner (probably the "D:" drive) or the jump drive you have plugged into a free USB port (probably the drive with the highest letter—maybe "E:" or "F:" or "G:"). Click Save.

If you are using a jump drive, the file will probably be downloaded directly into the jump drive. If you are using a CD burner—depending on the program your computer uses—the download may save the file directly onto the CD, or it may copy it into a temporary file first. If the latter situation obtains, a message will probably pop up on your screen saying something like "*You have files waiting to be copied onto CD. Click here to begin*." Complete the copying process onto your CD.

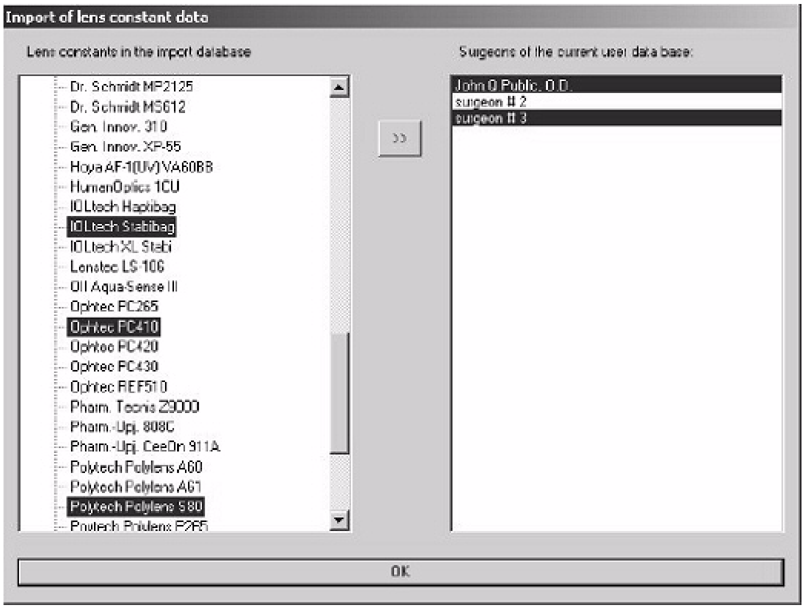
Importing Files from the CD or Jump Drive into the IOLMaster

Now you have a CD or a jump drive with a whole list of lenses that can be download into your IOLMaster. Make sure you've entered all the surgeons on the Administrator tab before proceeding.

1. You will want to be back in the Administrator tab for this. If you are already in the Surgeon / Lens files, just click on the Administrator tab (far left) to return to it. If you are back in the New Patient screen, click Options > User Database, select Administrator in the Name field and click OK to get back to the Administrator tab.
2. Install the CD into its drive (on the left side of the system's base when facing the screen) or the jump drive into its port (on the right side of the base). Give the computer a few seconds to recognize the CD or jump drive.
3. On the Administrator tab, click Import.



The import dialog that appears has a list of lenses on the left and doctors on the right.



4. Select the desired lenses by clicking on them. To choose more than one lens at a time, hold the Ctrl key while clicking every lens you want to import.
5. Select one or more doctors for whom you will import the selected lenses. Hold the Ctrl key while clicking to select multiple doctors. If each surgeon in your practice uses different lenses you will complete this process separately for each one.
6. Click the >> button to import the highlighted lenses into the lens database for the selected doctor(s).

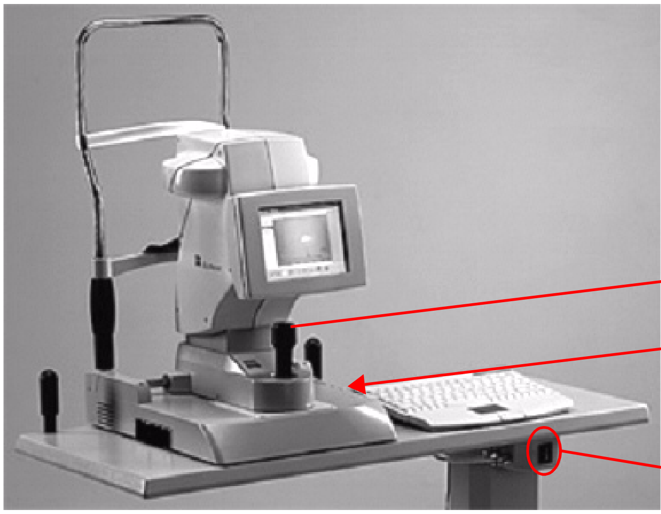
You may notice that not every IOL in existence appears on the list you downloaded. Recall that only lenses used often enough by the ULIB group to have sufficient data for lens constant optimization make it onto the site.

☞ **A very important note: If you have already optimized a certain lens, then you do NOT want to import that lens to your lens database on the IOLMaster. If you do, it will erase your optimized lens numbers and replace it with the website's numbers.**

(3) Preparing Your Patient for Testing

Now that we've covered the basics of what you will be testing and you have set up your user database, we are ready talk about how you will perform testing. The purpose of this chapter is to cover patient preparation *and* entering new patient data. The next chapter will cover actual measuring of axial length, corneal curvature, anterior depth, and white-to-white.

External Controls



While most of the external controls (the up/down button of the table, the knob to raise and lower the chinrest, etc.) will be familiar to most operators, there are a few details that warrant further explanation.

The "mouse" touchpad and buttons. At the bottom of the keyboard is a touchpad with left and right "mouse" buttons. If you have a laptop computer, you've probably used these before. But if not, here's how they work:

You can move your arrow-cursor around on the screen by putting your finger on the touchpad and then sliding your finger in the desired direction. When the cursor is over what you want to select, push the left "mouse" button (or you can sharply tap the pad with your finger, which sends the same signal to the computer as a click). A press of the left "mouse" button or tap on the touchpad is what we mean when we say "click" in this guide. (Right-click means to press the right "mouse" button.)

☞ **Note: You will always be using the left mouse button.**

Try to avoid moving the cursor with short strokes on the touchpad. Instead, place your finger on the touchpad and move the cursor using long strokes. This is because short, quick strokes can lead to unintentional “clicks” as you pick up and put down your finger repeatedly. So, until you are used to the pad, you may activate the wrong icon by mistake by using quick finger strokes on the pad, or even letting your wrist bump into it while you are typing.

If, after some practice, you find you can’t get used to moving the cursor with the touchpad, you can use a regular mouse instead. Just follow the keyboard cord along to where it plugs into the IOLMaster. There the cord splits into two plugs—a purple one for the keys and a green one for the mouse. Pull out the green plug and plug your mouse cord in instead. You’ll want to use a “normal” mouse (i.e. not the wireless or laser-operated variety) that has a PS2 plug.

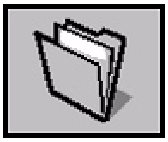
The joystick. You can raise or lower the IOLMaster scanning device by rotating the joystick knob. Rotating/twisting clockwise will raise the device upward, toward the patient’s forehead, while rotating/twisting counterclockwise will lower the device toward the patient’s cheek. You can also move the scanning device right and left, and forward and back, by moving the joystick in the same direction as you want to go. You will have better control over the scanner’s movements if you use two hands.

Patient Preparation Tips

Before you even begin testing your patient with the IOLMaster, there are some preparations you can make to increase the precision and accuracy of your testing:

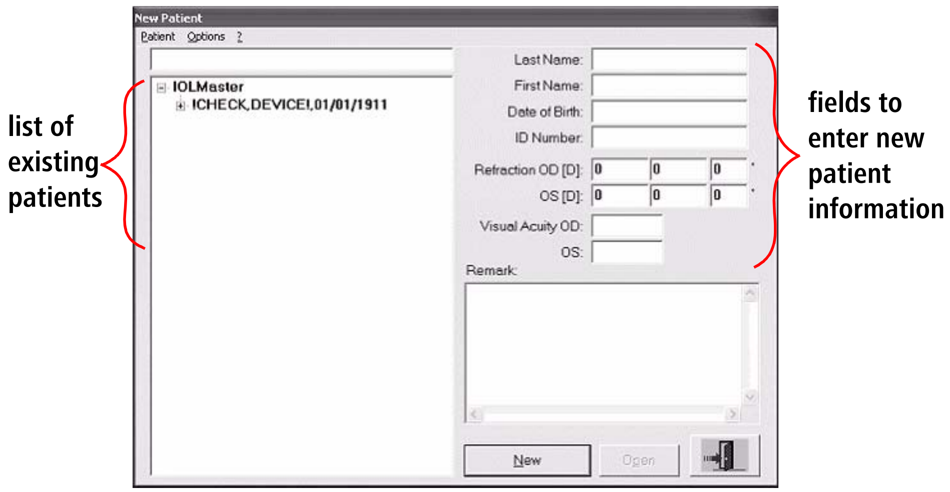
- Ensure corneal stability: Modern cataract surgery is not simply the removal of a clouded lens, it is refractive surgery. Patients expect good vision after surgery, without having to use glasses or contact lenses. One of the things that can interfere with good post-operative vision are pre-operative measurements made on an unstable cornea. Contact lenses warp corneas, sometimes just a little, sometimes a lot. If a patient wears contact lenses, make sure he or she leaves them out long enough for the cornea to return to a normal, stable shape before measuring. The use of refractions and topographies may be needed to ensure the cornea has ceased to change.
- Don’t touch the cornea: Schedule your IOLMaster testing in such a way that the patient’s eye has not been touched that day—such as from ultrasound A-scans, automounter pressure checks, gonioscopies, etc. Any and all of these tests can disrupt the tear film and corneal shape, thus throwing off measurements.

New Patient Screen: Entering New Patient Information



The first screen that appears when you turn the instrument on is a reminder that a daily calibration check of the IOLMaster is very important. (See Chapter (7) for instructions to perform a calibration check.) Click the OK button to move to the next screen, which is the New Patient screen. When you are in any of the testing screens, and you want to get back to the New Patient screen, just move your cursor and click on the *New Patient* icon, shown at left.

There are four important things you can do on the New Patient screen: add a new patient to test, select an existing patient to test, recall old test results, and delete unwanted files.



Adding a new patient to test

Make sure your blinking cursor bar is in the Last Name field at the upper right of the screen. If it's not, move your cursor there and click on the field. Now you can begin to enter the patient's data. Use the Tab or Enter key to move between fields.

You always must enter data for last name, first name, and date of birth; ID number may also be required, depending on the system settings. You can enter more information if you wish to, or simply begin testing.

If some fields contain information you don't want to be there (such as from the last patient you tested, or from accidentally having clicked on an existing patient's name in the list), click on the word IOLMaster at the top of the patient list. This will clear all the fields to give you a fresh start.

Click New at the bottom to begin testing. (The New button does not mean "new patient" in this context; instead, it means "new test.")

Selecting an existing patient to test again

If you want to re-test a patient who is already in the patient list, click the patient's name and then click New, or just double-click the name, and the test begins.

Recalling old test results

To find and view a specific test result for a certain patient, click the "+" to the left of the patient's name and their test dates will appear. To view a result, click to highlight the date you want and click Open, or just double-click on the date.

✪ Helpful hint: When trying to recall old tests, avoid double-clicking on a patient's name, or selecting a name and then clicking New. Instead of opening old test results, these actions will begin a new test and result in a new test date in the patient's list of tests.

Deleting unwanted files

If you want to delete an entire patient, click on a patient's name in the list and press the Delete key on the keyboard. You will have to confirm the deletion by clicking Yes.

If you just want to delete a particular visit, click the "+" by the patient's name, click on the date you want to delete, then press Delete on the keyboard. Click Yes to confirm your action.

☞ Note: If you delete the only date listed for a patient, then all data for that patient is deleted too.

(4) Taking Measurements

At this point you are probably anxious to get to the fun stuff, taking measurements! This chapter is broken into five parts.

- Part 1: Axial Length Measurement, below
- Part 2: Corneal Curvature Mode, page 4-14
- Part 3: Anterior Chamber Measurement, page 4-21
- Part 4: White-to-White Measurement, page 4-26
- Part 5: Calibration Check, page 4-28

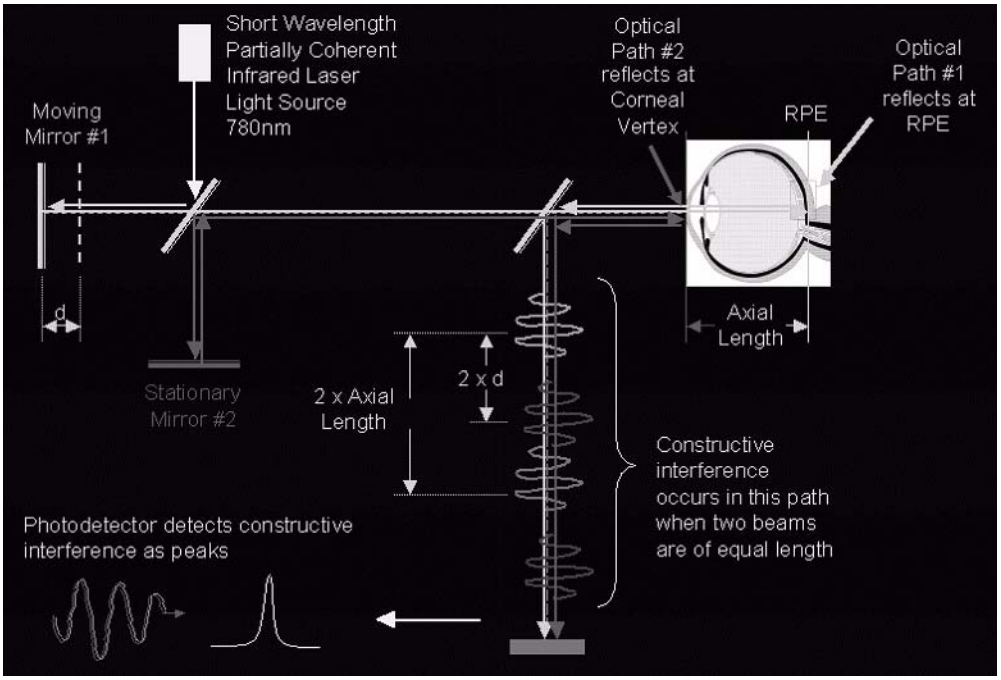
If you are reading this chapter, it is assumed you are already familiar with the information provided in the previous chapters. You will also notice that in this chapter we include sections called "Best Practices." These are included to highlight what we consider the best ways to use the IOLMaster. We hope this is helpful.

☞ Important Note: As you learn about taking measurements as explained in this chapter, it is important that you practice these techniques on a fellow technician—not on an actual patient who will have cataract surgery. You must be proficient with these measurement techniques before performing them on patients. **It is also extremely important that you check the calibration of your IOLMaster every day before taking measurements on actual patients. Please see Part 5: Calibration Check (page 4-26) for detailed instructions to check the calibration.**

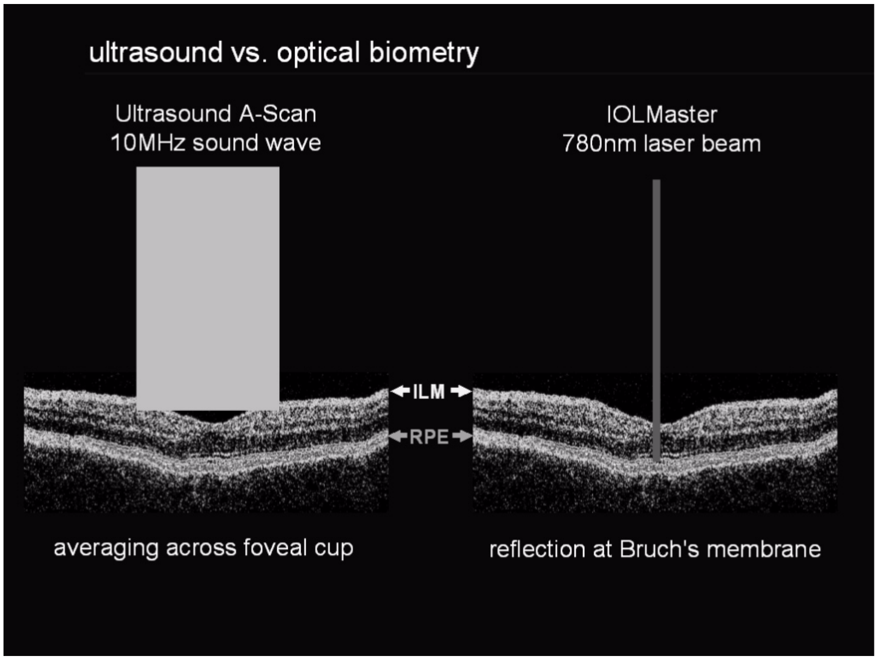
Part 1: Axial Length Measurement

How Does It Work?

See the illustration below for a detailed description. Basically, the IOLMaster uses light to measure the axial length of the eye, the distance from the front surface of the cornea to the retina; whereas A-scan ultrasound uses sound waves to measure this distance.



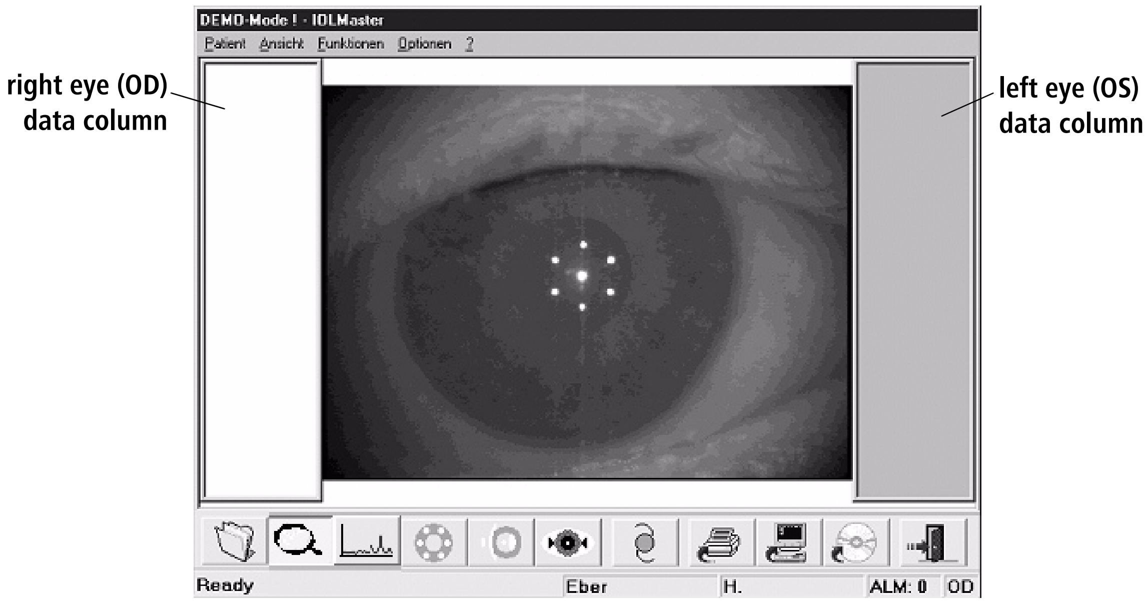
☞ Important Note: Unlike A-scan ultrasound, which reflects off the wide cupped surface of the macula, the IOLMaster beam passes through the translucent surface of the retina and back further to the more opaque pigment layer. The computer corrects for this difference.



In addition, the use of contact ultrasound will indent the cornea, thus decreasing the distance between the cornea and the retina and artificially shortening the axial length measured. Because of this, axial lengths measured on the IOLMaster are almost always longer than those obtained through contact ultrasound.

How to Perform the Test

Once you click the New button back on the NEW PATIENT screen, your screen changes into testing mode. A video image of the eye appears in the middle of the screen and a row of icons appears along the bottom. Empty columns (soon to be filled with data) appear to the left and right of the video image.



Have the patient come forward into the chinrest. Get the eye lined up with the red marker, and make the patient comfortable by raising or lowering the table. The patient can hold onto the handle bars at either side of the IOLMaster, if needed.

The instrument knows which eye you are testing by which side the scanner is moved to. When you have the scanner in front of the patient's right eye, data will appear to the left of the video image. When you have the scanner in front of the patient's left eye, data will appear to the right of the video image.

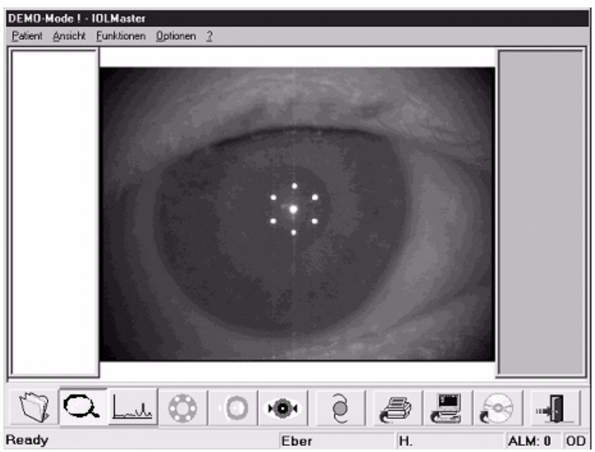
Tell your patient to always stare straight ahead at the spot of light. The spot will change color, depending on which part of the test you are performing, but it will always be straight ahead. Allow the patient to blink normally. Tell the patient you will inform them when they need to stop blinking.

When you first come to this screen—or when you've just switched from one eye to the other—you'll notice that the magnifying glass icon at lower left has been selected automatically. This indicates you are in Overview Mode.

Overview Mode

This is the first screen that appears when you click **New** to begin testing. If you are on a different testing screen, and wish to return to Overview Mode, just move your cursor over the *Overview* icon and click. Alternatively, you can press the letter "O" on the keyboard.

Note that the Overview Mode is NOT a test. It is just your chance to get lined up with the patient's eye. So you do not have to spend much time here at all…close is good enough.



1.First, move the scanner left and right as needed, and rotate the joystick to move the scanner up and down as needed, to get the green cross-hairs over the dark pupil of the eye.

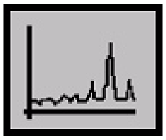
2.Next, move the scanner forward toward the patient or pull it back away from the patient as needed to focus the image of the eye. You will know when you are in focus because the little spots of light reflecting in the pupil will become very small and sharp. But remember, this is NOT a test, so don't stress about whether or not the spots are perfectly focused…you're going to have to re-focus anyway in a few seconds.

Helpful hint on focusing: If you are moving toward the patient and the lights are getting smaller and sharper, then you're on the right track. But if you are moving toward the patient and the lights are getting larger and fuzzier, then you have gone too far—start pulling back toward you until the spots of light get smaller again. For practice, feel free to "overshoot"—that is, keep going forward and the lights will start to get larger and fuzzier because you've gone too far in that direction. This way, you will learn how small the lights are supposed to get, and you'll know what it looks like when you're in focus.

3. Finally, *without moving the joystick,* push the button on top of the joystick. This will advance you to the next part of the test.

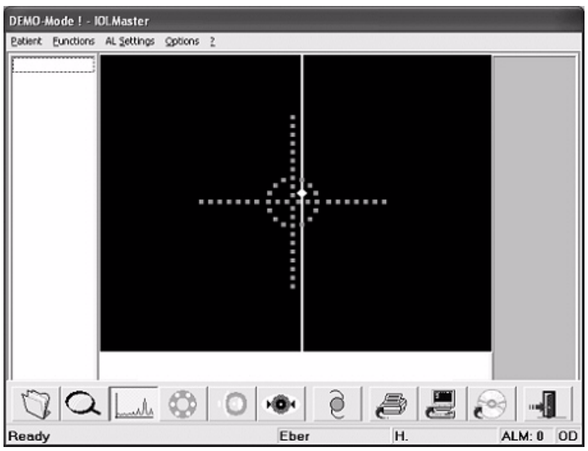
Axial Length Mode

This is the "A-scan" test, but performed with lasers instead of ultrasound. The test moves into this mode when you push the joystick button at the end of the Overview



Mode. However, if you are on a different screen, and wish to return to Axial Length Mode, just move your cursor over the *Axial Length* icon and click. Alternatively, you can press the letter **"A"** on your keyboard.

In Axial Length Mode, the eye zooms in very close, so the pupil fills most of the screen. If you ever "get lost" and cannot find the center of the pupil, just return to Overview Mode by clicking on the magnifying glass icon, or by pressing the **"O"** key on the keyboard.



1.First, get your spot of light somewhere within the green circle. If you've entered this mode directly from Overview Mode, your spot of light will probably already be in the circle. Otherwise, move the scanner left and right as needed, and rotate the joystick to move the scanner up and down as needed, to get the spot of light within the green circle.

The spot of light just needs to be somewhere within the green circle. It does not need to be "dead center." Sometimes, in fact, intentionally moving the spot around within the circle will help you to scan around a dense area of the cataract.

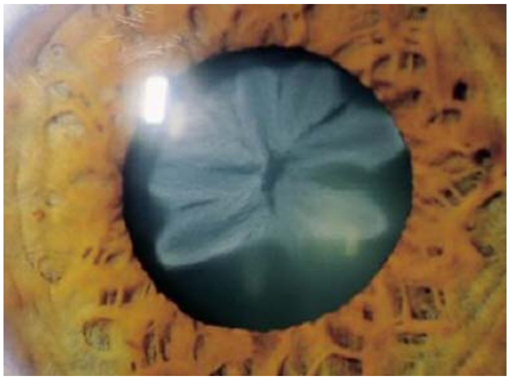
2. Next, you'll want to focus the spot of light. Again, if you've just come here from Overview Mode, chances are the spot will be fairly small and sharp already. But if not, move the scanner forward toward the patient or pull it back away from the patient as needed to focus the image on the eye. You'll know you are in focus when the little spot of light on the pupil becomes very small and sharp.

   Sometimes it's hard to tell if the spot is really as small and sharp as it can be. But you can double-check your focus by looking at the vertical line of light that extends up and down from the central spot. If this line is thin and sharp, then you're in focus!

3. Now, say to the patient: **"Blink a couple times…now stop blinking and look straight ahead at the light."** Push the joystick button. The screen flashes for a second, and then a number appears in the left or right eye data column. (If you're testing the right eye, the number appears on the left, and vice versa.) This number is the axial length (or "AL" for short), which is the length of the eye—the distance from the cornea to the retina—measured in millimeters (mm).

✐ ***Best practice:*** *The IOLMaster requires you to take at least 5 measurements. It is a good idea to take these five measurements with the white light in different quadrants of the green circle. Take the first one in the center, and then for each successive measurement, rotate the joystick to move the white light and take a measurement in each of the four quadrants of the green circle. We also recommend that you take two more measurements: one after you pull the joystick back and defocus the light to the size of the green circle; and a second after you push the joystick in towards the patient again This will give you a total of 7 measurements.*

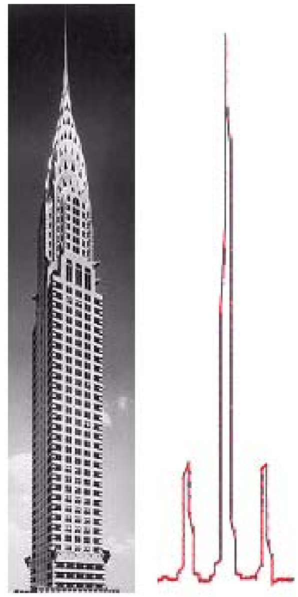
The reason for taking measurements in this way is to try to "get around" some of the denser opacities of a patient's cataract. The image below shows how cataracts have varying opacity in different areas of the lens, and you may find that you get a better signal in areas where the cataract isn't as dense.



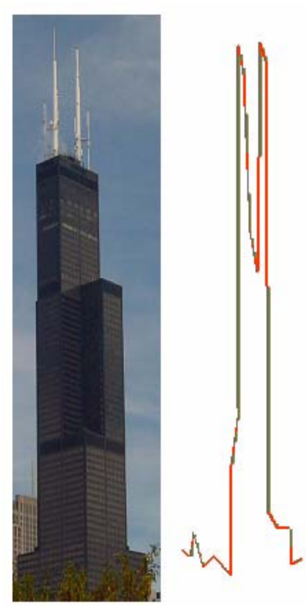
4. Evaluate your results. You can evaluate the quality of your scans in two ways: First, by evaluating the waveform graph itself, and second, by the SNR value.

Evaluating the Waveform Graph

The waveform graph is the red, spiky line superimposed on the video image after each push of the button. A good graph should have one tall spike ending in a clearly defined single peak, like the one shown below next to the Chrysler Building. There will be a row of smaller spikes appearing on either side of the primary central spike, with each of the smaller spikes becoming shorter and shorter until they become a flat line of “background static”.



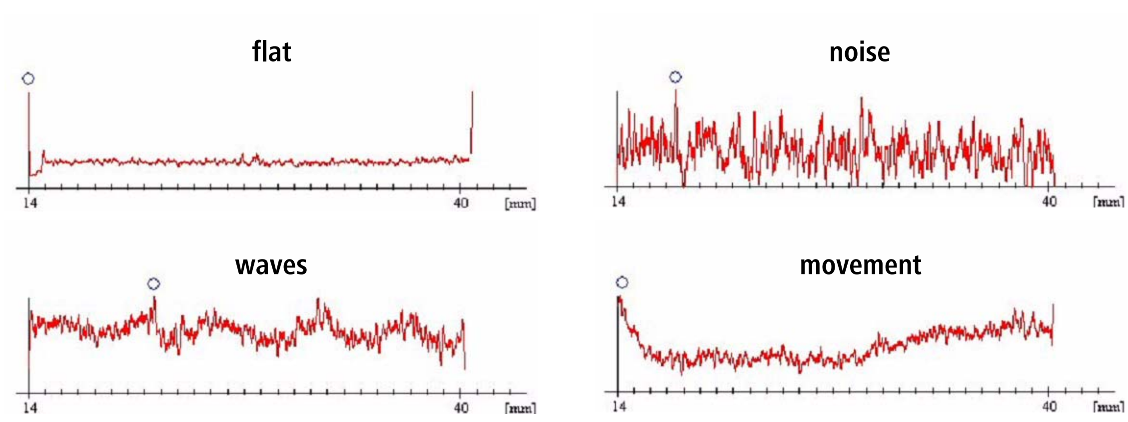
Chrysler Building, New York City = Ideal waveform



Sears Tower, Chicago = Double peak

A double peak, like that shown next to the Sears Tower, is not considered a good graph. Because there are two peaks, the instrument isn’t sure where to place the measurement cursor, and this can result in erroneous measurements. A little later we’ll tell you what to do when you get a double peak.

The more interference with a scan—usually from dense cataracts—the higher and shakier the “background static” line will be. A blink or eye movement will cause a section of the graph to “bottom out” to nothing. See below some examples of poor scans.

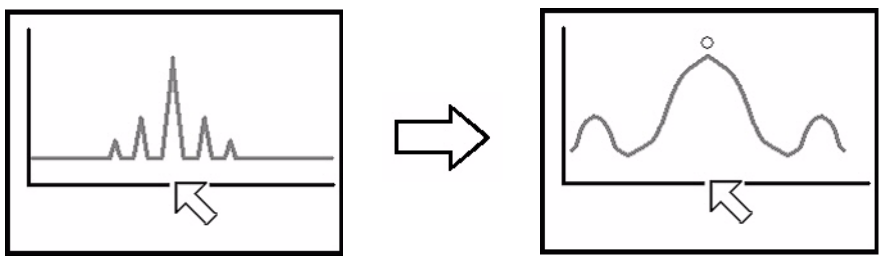


With scans like these, the word "error" will appear in the list of axial lengths, instead of a number. To delete such erroneous measurements, click to highlight the word "error" and press the Delete key.

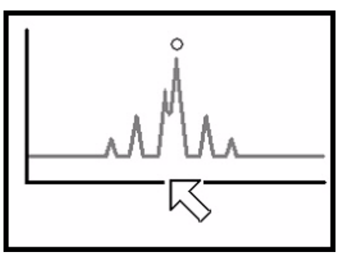
What to do with double peaks

Double peaks are caused when it is unclear which retinal layer is providing the brightest reflection. Patients with a blond or otherwise pale fundus, or with macular pathology, or who are fixating slightly off center, may have double peaks in their graphs

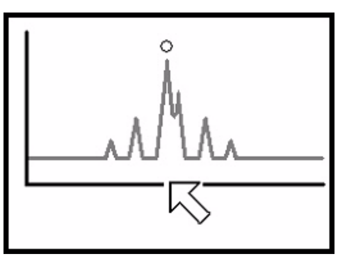
First of all, if you suspect that you have a graph with a double peak, you can check this by zooming in on the graph. To zoom in, click the black "x-axis" line directly below the red spike. If you still can't tell, zoom in further the same way: again click the black "x-axis" line directly below the red spike. Right-click to go back to the original graph size.



If there's only one peak, and the graph looks typical, then use this as your "anchor" and delete all measurements that are not within 0.05 mm of this number.



If there are two peaks, whichever peak is clearly the taller of the two will automatically have the dot above it. If the dot is over the top of the right-hand peak, then you're probably still okay. Just pick another graph or two. Try to find a graph that has just a single peak with a dot over it, and use that as your "anchor" to know which measurements to delete.



If there are two peaks, and the dot is between the two peaks, or the dot is over the left peak…then we have a problem. See the Best Practice section below for further information.

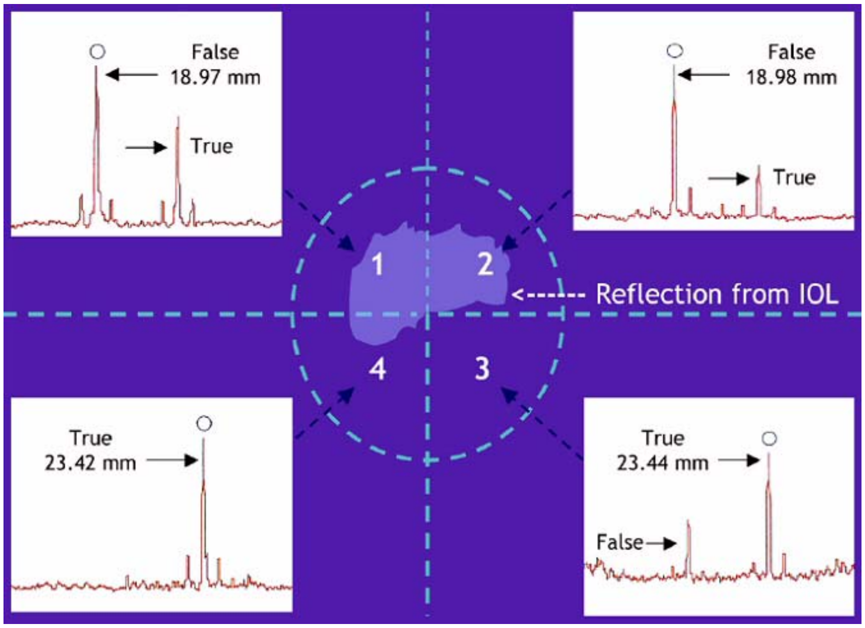
If both peaks are of fairly equal height, then the computer will "split the difference" and put the dot between them.

Best Practice: If you have a graph with two peaks, it is probably simplest and best to delete the measurement that goes with the double-peak graph and take a few more measurements, trying to get more single peak graphs. However, for some patients—especially patients with blond or pale retina or with macular *pathologies—most of your graphs may end up having double peaks. If you were to delete all double peaks, then you would not have enough "good" measurements left! So again, the right-hand peak is usually the correct one. Just save all the measurements that have a dot over the right-hand peak, and delete all the measurements with a dot in between or over the left peak. Although it is possible to move the measurement cursor to a different peak by holding down the left mouse button and dragging it to a different peak, doing this will change the axial length measurement. Therefore, we don't recommend that you do this unless you are very experienced with this process. Please see the user manual for more detailed information on how to do this.*

Double peaks from patients with an existing IOL

When measuring a patient with a phakic IOL or a patient who is pseudophakic from previous cataract surgery, it is possible to get a double peak that can severely throw off of the axial length measurement. The instrument will sometimes pick up a reflection from the IOL, creating a false peak and making the axial length erroneously short.

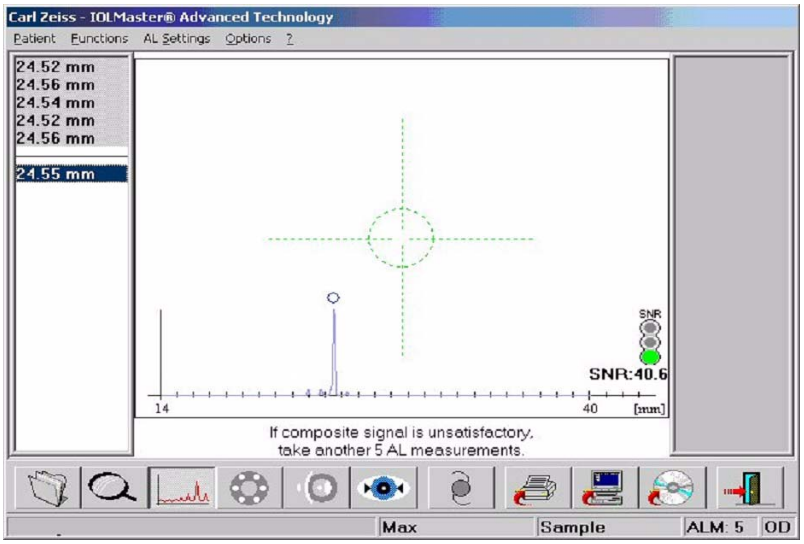
✐ *Best Practice: As shown in the image below, try to move around taking measurements in different quadrants and thereby avoiding reflections.*



This process is similar to trying to get around the denser portions of a cataract. Most importantly, use your own judgement: if you see an axial length measurement abnormally short as in the case below, be aware that something like an existing IOL probably is causing an erroneous measurement.

New Composite Graph

This is a new feature introduced in version 5 software. After you have taken five axial length measurements, a composite graph will appear in blue, with an SNR traffic light. (See Signal-to-Noise Ratio or SNR on page 4-10 for an explanation of this feature.) Underneath the original five measurements will appear a single composite value. Unlike previous versions, this composite value is not an average; IOLMaster calculates the composite value by combining the individual signals, which significantly increases the signal to noise ratio.



If individual axial lengths differ by more than 0.05 mm from their mean, the message "multiple peaks" will appear. This does not mean the composite signal is unreliable, nor that the (composite) axial length is incorrect. However, in such cases, we strongly recommend that you closely review the composite signal and the individual axial lengths; as you review, adhere to the *Best Practice* described under What to do with double peaks, on page 4-8.

Signal-to-Noise Ratio or SNR

The SNR, or Signal-to-Noise Ratio helps you evaluate how high your peak is compared to the "background static" line. This number appears in the lower-right corner of the screen after each measurement. After five or more measurements, a "traffic light" appears along with the SNR value.

If the SNR is too low (less than 1.6), a red "stop light" will appear above it and the word "error" will appear in the data column instead of a measurement.

If the SNR is of borderline quality (between 1.6 and 2.0, inclusive), a yellow "caution light" will appear above it and a numeric AL value will appear in the data column, but it will have an exclamation mark ("!") after it.

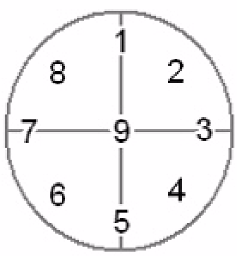
If the SNR is high enough (above 2.0), a green "go light" will appear above it and a numeric AL value will appear in the data column as normal.

☞ **Important Note: A high SNR does not necessarily mean you have a good scan. A blink, for instance, often produces a very high SNR because the distance between the highest peak and the "bottomed out" background static is quite a lot. Another possibility is having a great central spike height—and thus a good SNR—but retinal pathology causes the peak to be split in two, providing the wrong results. In short, the SNR is relevant only when taken in conjunction with the appearance of the graph.**

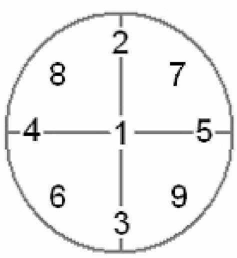
✐ ***Best practice:*** *After you have taken 5 measurements, if you don't have a "green light" above the SNR value, you should take more measurements until you do have a "green light."*

☞ **Important Note: Because IOLMaster measures with a laser, the system will allow you to attempt the measurement up to twenty times. Even if you delete some measurements, the system still will prevent you from acquiring more than twenty measurements per eye each day.**

Some practices regularly take **all twenty** measurements instead of taking only the required five. Once you have become practiced and efficient at obtaining axial length measurements, it only takes a few more seconds to acquire all twenty measurements, compared to the required five. This increases your likelihood of obtaining a valid reading, and also improves your skills in obtaining good scans.



As you are taking measurements, intentionally move the spot of light around in the green circle and take each measurement at a new location. Depending on the type and density of the cataract, some areas may be easier to measure through than others. There are two ways to tell if one area of the green circle is better for scanning through than another: looking at the waveform graph shape, and looking at the SNR number.



Pictured at left are two simple patterns you could use to acquire multiple measurements through different locations. The first is a clockwise pattern starting at the top. The second is a zigzag pattern in which you slide to opposite sides of the circle. There is no right or wrong order—if you even have an order at all—but having one can help you remember which location works best for that eye.

As you measure through various sections of the circle, make a mental note of which areas of the circle work best—that is, have both a “typical” graph and have a higher SNR number. After your first ten measurements or so, you should know where the “hotspot” is. Return to that spot, and finish taking your twenty measurements there.

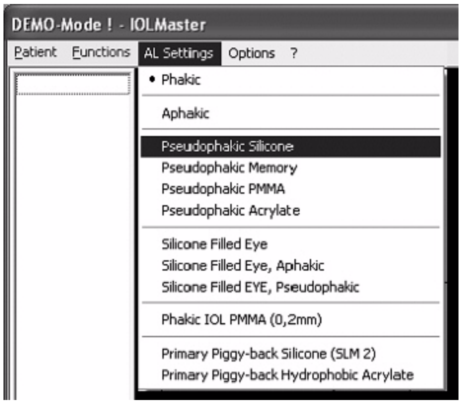
✪ Helpful hint: Each time you push the joystick button, you will see the pupil light up for just a moment. Often you will be able actually to see the dark cataract against the background flash. Remember where the cataract was—such as a Cortical Spoke coming in toward the center from the five o’clock position, or a central PSC that seems darker more to the left than the right—and try to move your spot of light away from those darker areas.

Some patients have cataracts that are simply too dense—either overall or just centrally—for the laser to safely penetrate. If every measurement is either “error,” has a strange-looking graph, or produces numbers too inconsistent to know which ones to keep or delete, then you must resort to using your ultrasound unit to measure axial length.

What About Eyes That Have Already Had Surgery?

If the eye has had refractive surgery, such as LASIK or RK, there is no difference in measurement technique (neither in Axial Length Mode nor in the Corneal Curvature Mode we will explain later). The effects of having had surgery come into play after taking measurements, when it’s time to calculate for the lens implant.

If the eye has had previous cataract surgery or some type of retinal surgery, take your cursor and click the AL Settings menu at the top of the screen. The menu opens showing options for various types of eyes. Click an eye type and the axial length measurement will change based on the computer’s re-analysis of the wave patterns. The AL Settings options are:



- Phakic – This is the default setting. Phakic eyes have their natural crystalline lens or cataract still in place, and have had no other invasive surgery.
- Aphakic – This means that the natural lens has been removed, but no implant has been put in its place.
- Pseudophakic – This means that the natural lens has been removed and replaced with an implant. Note that there are four different types of lens materials to choose from (Silicone, Memory, PMMA, and Acrylic). If you are unsure of the type of lens it is (patients often do not keep the lens identification cards their surgeon gave them), a good guess would be PMMA. If you guess

wrong, your new axial length will only be 0.01 mm off target, which is such a small amount it won't affect your lens calculations.

- Silicone Filled Eye – This means the eye has been filled with silicone oil (probably after retinal surgery), but still has the natural lens intact.
- Silicone Filled, Aphakic – This means the eye has been filled with silicone oil and the lens has been removed (probably during the same surgery), but no implant has been put in its place.
- Silicone Filled, Pseudophakic – This means the eye has been filled with silicone oil and there is an implant present.
- Phakic IOL – This means the eye has both its natural crystalline lens and a lens implant (which was probably inserted as an alternative to LASIK).
- Primary Piggy-back – This means the eye has two separate lens implants. You can choose from Silicone or Acrylate.

What About Extremely Farsighted or Nearsighted Patients?

Some patients have prescriptions that are so great that they can barely even see the light in front of them, much less fixate on it. In such cases, you may want to have them wear their glasses—but not contact lenses!—for the axial length measurement.

Are we done yet?

If you have a good composite graph with a green light on the SNR stoplight, you're probably okay to proceed to the K's. But just in case, you should do a quick double-check. Look over your measurements to make sure everything makes sense. If all of your measurements are about the same number, you're okay to proceed to the corneal curvature measurements. If not, use the up and down arrows on your keyboard to quickly scroll up and down your list of numbers. Use the information you have learned in this chapter to decide which numbers to delete, if any.

☞ **Important Note: Deleting single measurements merely because they have a low SNR may negatively influence the composite signal. The idea behind the composite algorithm is to produce a composite signal with a good SNR from a number of single measurements with varying SNRs.**

New with version 5 software: Axial Length Guidelines for Best Practices

- A good composite signal has a SNR above 2.0.
- A borderline value is between 1.6 and 2.0.

- Below 1.6 no AL is displayed.

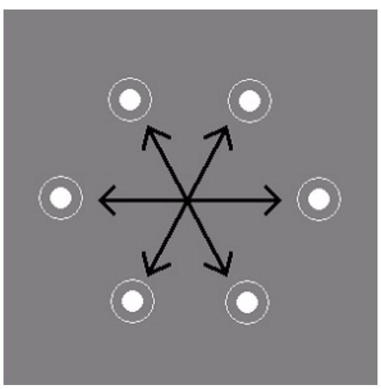
Take a closer look at the composite signal peak's shape ("Chrysler Building" single peak or "Sears Tower antennas" double peak), especially if the warning "multiple peaks" is shown. Go through the single measurements and try to determine which peak is the correct one, especially if the composite peak's shape is like the "Sears Tower antennas" double peak. If possible, perform additional measurements. If necessary, move the measurement cursor (circle) to the correct peak on the blue composite graph. The AL measurement for the other eye may help you decide which is the correct peak.

Do not delete single measurements because they are identified as outliers (AL is printed in RED) or have low SNR ("Error" warning). The reason is that the software already recognized them as outliers and has printed the AL in RED. Even a low SNR signal may contain significant information for the correct AL. That is the rationale for using the composite signal.

☞ **Important Note: With the latest version 5 software the "Error" warning in single measurements has been replaced by dashes "- -" (You do not have to delete these measurements if there is a good composite signal and AL value).**

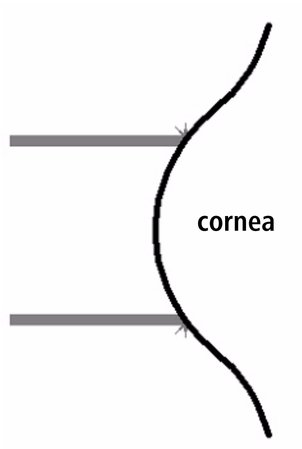
Part 2: Corneal Curvature Mode

How Does It Work?



Six spots of light are projected onto the cornea in a hexagonal pattern with a diameter of about 2.5 mm, so the distance of each spot to the visual axis is about 1.3 mm. The position of each pair of reflection spots is detected and measured by the computer; the relative positions of each pair are compared to determine corneal curvature and astigmatism as a radial measurement.

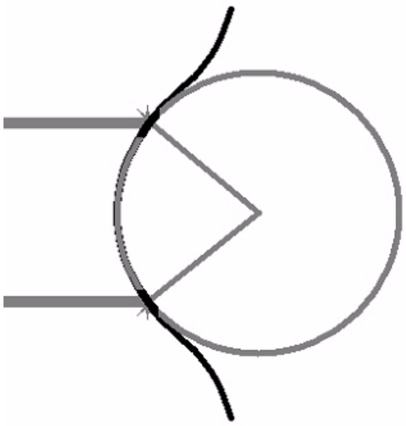
A radial measurement is the radius (that is, half the diameter) of an imaginary circle drawn on the cornea (and extending axially into the eye) connecting each pair of points. This measurement is made as shown below.



Here is a side-view of a cornea. Notice how it is not perfectly round, but more like a "bell curve". In this representation, there are two beams of light shining on the cornea—those beams represent two of the six beams that shine onto the cornea to give the six reflective spots of the Corneal Curvature Mode.

From the positions of the focused spots on the cornea, the computer can tell how curved the cornea is at each spot. The nearness of the spots to one another indicates how steep or flat the cornea is between those points. Flatter corneas cause the spots to be located further from one another, whereas steeper corneas cause the spots to be located closer together.

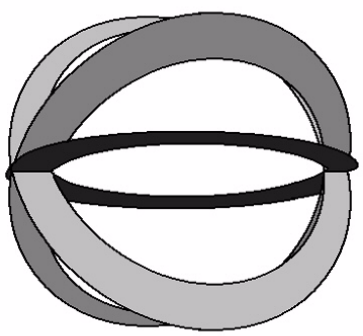
The computer determines the radius—an imaginary line that extends into the eye perpendicular to the corneal surface from the reflection spot. These two lines meet at the center of the imaginary circle. The corneal surface between the two points of reflection are sections of a circle, while the point where the two lines meet is the center of this same circle. Thus, an imaginary circle is formed, and the lines to center are radii of the circle. The size of this imaginary circle is determined by the reflection points—points that are closer together will produce smaller circles and smaller radii, while points that are further apart will produce larger circles and larger radii.



Here is the imaginary circle superimposed on the cornea. Notice how the circle coincides with the central corneal surface, but not necessarily the peripheral surface. Since the central area of the cornea is more relevant to vision, the spots of light are also fairly central—the central 2.5 mm—in order to match the circle up with the important central corneal curvature.

Do you see how the reflection points of the parallel beams of light define radii as they converge at a the circle's center point? This is the real key to understanding radii: the radii converge at the center of the circle formed by the central corneal surface, just as light rays are focused—caused to converge—by the cornea. A flatter cornea means a larger circle and longer radii—which in turn means the focal point is further back in the eye. A steeper cornea means a smaller circle and shorter radii—which in turn means the focal point is closer to the cornea.

☞**Important Note: The circles shown are not to scale with the cornea (the circles and their radii will typically be much larger compared to the cornea), but this should give you and idea of what's going on.**



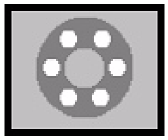
In the illustrations above, we've seen two of the six reflected spots of light. If every cornea were equally curved all the way around, two spots is all we would need. But of course that would make things too easy. In reality, almost every cornea has a detectable amount of astigmatism—that is, the cornea has irregular curvature. For example, it may have a steeper curvature along the 90 degree axis and a flatter curvature along the 180 degree axis. Because of the possible irregularity, multiple areas of the cornea must be tested. In the end, all of the circles and their radii are combined together into one set of measurements showing the steepest curvature and at what axis, the flattest curvature and at what axis, and the difference between the two.

Finally, the computer converts these composite radial measurements into the more familiar diopters. Whereas radius is a measurement of shape, diopter is a measurement of light-bending power. A lens with one diopter of power can focus parallel rays of light to a point one meter behind the lens. A lens with two diopters can focus the light closer, to one-half of a meter. Three diopters focuses to one-third of a meter; four diopters to one-fourth of meter, and so on.

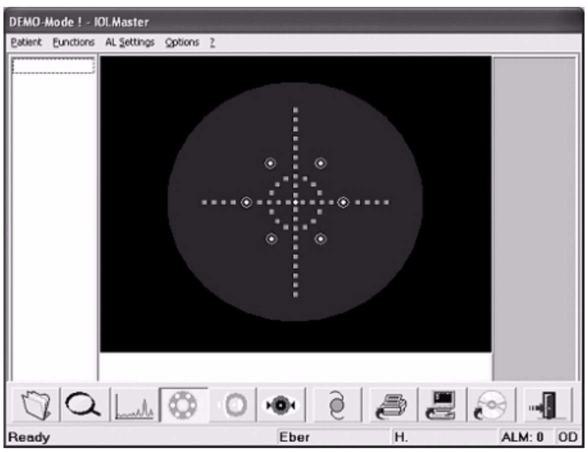
The computer determines the total corneal power from the anterior curvature of the cornea using the keratometer index of 1.3375.

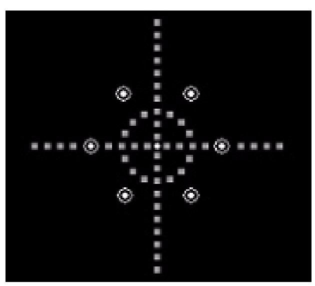
How to Perform the Test

Keratometer Mode - Manual



This is the measurement of how steep or flat the cornea is. The test moves into Keratometer Mode when you press the space bar while in Axial Length Mode. To return to Keratometer Mode from another screen, click the ***Keratometer Mode*** icon. Alternatively, you can press the letter "K" on your keyboard.





1.First, move the scanner left and right as needed, and rotate the joystick to move the scanner up and down as needed, to get the spot of light "dead center" in your target. Unlike the axial length test, the spot can't be just anywhere in the green circle—it must be right in the center.

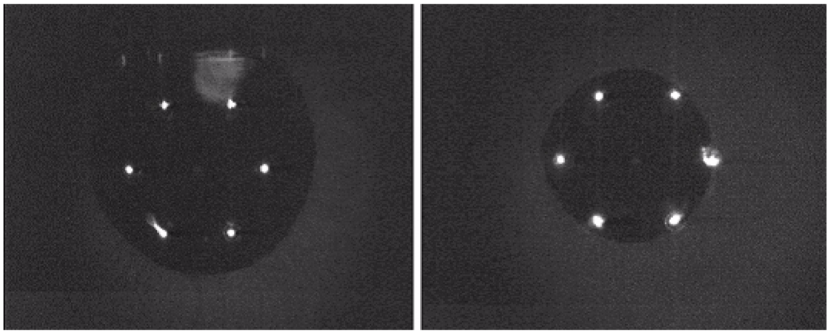
2.Next, you'll want to focus the outer six lights. Because the cornea is curved, the central spot is nearer to the scanner than the outer six spots. Therefore, you cannot have both the central spot and the outer six spots focused at the same time.

Best Practice: *In summary, while you want to center the central spot, you want to focus the peripheral spots. Being in focus means having the lights small and sharp. When in focus, most, if not all, of the six outer spots will have thin rings or halos around them—like a view of Saturn from above. Look for these rings to make sure they are in focus.*

Helpful hint on focusing the peripheral spots: If you are having trouble getting the outer spots in focus, first focus the central spot to be as small and sharp as possible, then pull the scanner back toward you *just a hair*, and the outer spots will come into focus.

3. Now, say to the patient: "Blink a couple times…now stop blinking and look straight ahead at the light." Before you push the joystick button, take a quick look at the six spots: are they all small and sharp, or are one or two of them blurred, or have streaks coming out from them? Blurred or streaked spots will not be analyzed well. In this case, have the patient blink a few more times—have them blink rapidly for a few seconds, then stop. The blurriness and

streaks should be gone, so now you can push the button. Push the joystick button, and the system acquires three measurements in rapid succession. The measurement values appear in the left or right eye data column as usual.



✐ *Best Practice: Have the patient blink between EACH PUSH of the button. Patients tend to stare during such tests, which drys out the cornea. Rather than having the patient blink a time or two at the beginning of each testing mode, have them blink a time or two between each push of the joystick button. A good tear film will help with all the tests, especially the K's. Using a light artificial tear can help smooth the tear film if a patient has extremely dry eyes, but do not use a very viscous brand of tears. This can add too much of a tear film, making the reflective surface irregular and unstable.*

Trouble with one or both of the top two spots typically results from the upper eyelid drooping down too low. If you see this happening, tell the patient to "open wide" after the blink. If that doesn't work, you may have to reach around to hold it up yourself, or have a colleague help you to do so.

The numbers you obtain here describe the corneal curvature and its light-bending power (or simply "Ks" for short).

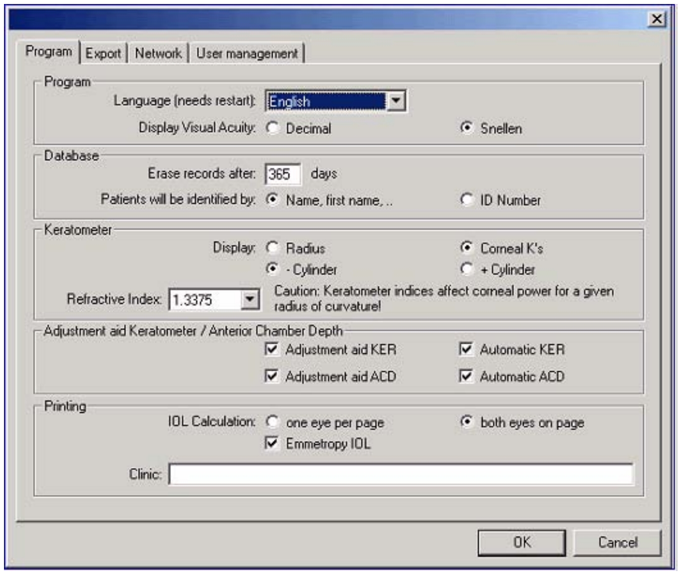
4. Note and act on what appears just *below* your list of three measurements:
   - If an average of the three measurements appears, you're done with that eye.
   - If the word "evaluation" appears, delete one or more of the measurements and try again, until an average appears. Don't forget to have the patient blink between measurements.

New with version 5 software: Keratometer Mode – Automatic

If only one measurement is acquired instead of three, you are in manual mode. Press the "M" key on the keyboard to switch to automatic mode.

☞ Important Note: With the latest version 5 software, there will be only one beep after the last of the 3 measurements.

You can have the instrument default to automatic mode by changing a setting in the **Program Settings** menu. Select **Options** > **Program Settings** and select the **Automatic** checkbox in the **Keratometer** area.



You will also see a checkbox to select **Adjustment aid**. Selecting **Adjustment aid** provides you a traffic light symbol that indicates the status of your focus.

- Red light = System out of focus
- Yellow light = System near best focus
- Green light = System in best focus position.

As always, be sure the central spot is “dead center” in the target, and that the six peripheral lights are small and sharp—preferably with those thin “Saturn rings” around them. Remind the patient to look straight ahead at the light.

Press the joystick to activate automatic acquisition; the system will acquire three measurements in rapid succession, as long as the optimum measurement condition (green light) has been reached. Press the **“M”** key to switch back to manual mode.

If an average of the three measurements appears, proceed to Part 3: Anterior Chamber Measurement (page 4-21). Just press the space bar on your keyboard to advance to this mode.

If the word “**evaluation**” appears, then the largest number (steepest curvature) and the smallest number (flattest curvature) are more than a quarter diopter different on average.

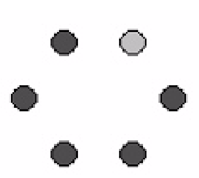
The computer determines this by averaging each of the three sets of numbers into three “invisible” average numbers. These three separate averages do not appear on the screen; the computer simply does the calculations internally. If the largest and smallest average are more than a quarter diopter apart, the word “**evaluation**” will appear at the bottom of the list rather than a number.

If you are fairly certain which of the three measurements is incorrect (for example, you saw the patient move or blink during that measurement, you saw some debris float through the tear film, you were out of focus or off center when you pushed the joystick button, etc.), go ahead and delete that one and see if the average number appears at the bottom of list. If it does, go ahead and take one more measurement to make a total of three (just to be sure). If it still says “**evaluation,**” delete the remaining two and start over fresh.

✪ **Helpful Hint:** Much like the axial length measurements, a “traffic light” appears to help determine the quality of your image.

✘ Troubleshooting

The main cause of getting “**evaluations**” at the bottom of the list—or getting “**errors**” instead of numbers—is missing or blurred spots of light. Sometimes the computer still has enough information to obtain consistent results and give you an average, but sometimes not, and you have to work a little harder to get three good measurements.



Conveniently, if the computer notices a blurred or missing spot of light, it will warn you of this after you push the joystick button by showing you a small image at the bottom of the screen. This image has six small dots like the six spots of light on the cornea. One or more of these dots will be flashing to indicate which of the corresponding spots of light the system is having trouble measuring.

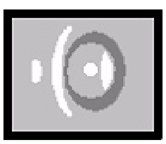
If you have tried all of our suggestions but you are still getting “error” messages instead of readings you can, if all else fails, obtain the K’s from a different source (such as an ATLAS Corneal Topographer or a manual keratometer) and manually type these alternative measurements in when performing the lens calculations (see Chapter Five for details). However, using non-IOLMaster corneal measurements involves its own set of risks and difficulties, so it’s best to keep trying to get the K’s with the IOLMaster, see a more detailed explanation of this in Chapter Five. Unlike the Axial Length Mode, this part of the testing is not a laser, so you can try as many times as you like!

☞ **Important Note: Regarding K's from other sources, you may notice that the IOLMaster may provide slightly different corneal curvature measurements than manual keratometry. This is for several different reasons:**

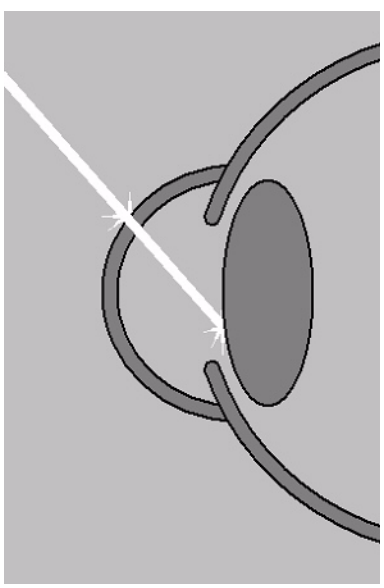
- First, manual keratometry measures the corneal curvature more peripherally—perhaps at 3.0 mm or 3.2 mm, depending on your manual system—while the IOLMaster measures the more relevant central curvature at 2.5 mm. Thus on a typical eye, IOLMaster K's will be slightly steeper than manual K's, while on a post-refractive eye, the IOLMaster K's may be slightly flatter.
- Second, the IOLMaster determines curvature by measuring the relative position of six spots on the cornea, rather than the two mires of manual keratometry, thus providing more detail.
- Third, if your IOLMaster is set to give curvature results in diopters rather than millimeters radius, the original radius is converted into diopters using the keratometer refractive index of 1.3375, as opposed to some other keratometry systems.

Part 3: Anterior Chamber Measurement

Anterior Chamber Depth (ACD) Mode



In ACD mode, you measure the distance from the cornea to the front surface of the natural crystalline lens (a measurement that certain more advanced calculation formulas require). The test moves into this mode when you press the space bar from the Corneal Curvature Mode. To return to ACD Mode from another screen, click the *Anterior Chamber Depth (ACD)* icon at the bottom your screen. Alternatively, you can press the letter "D" on your keyboard.



How Does It Work?

A slit-beam is projected from the side of the scanner; it passes through the cornea at an angle, and continues on to the crystalline lens. It reflects from the surface of the cornea and from the lens surface. The computer measures the distance between the corneal reflection and the lens reflection and, along with the corneal curvature obtained in the previous mode, computes the distance from the cornea to the lens.

How to Perform the Test

When you first come to Anterior Chamber Depth (ACD) Mode, you will see three spots of light (two close together off to the side, and one by itself near the center of the screen), plus two curved arcs of light. For the time being, ignore the pair of spots and the two arcs, and concentrate only on the solitary spot of light.

1.First, get your spot of light inside the green box. It can be anywhere as long as it stays within the green box. If entered this mode directly from Overview Mode, the spot of light probably will be in the box already. Otherwise, move the scanner left and right as needed, and rotate the joystick to move the scanner up and down as needed, to get the spot of light within the green box.

2.Next, move the scanner forward toward the patient or pull it back away from the patient, as needed, to focus the spot: make it as small and sharp as possible.

3.Now that the spot is small, move the scanner to the right or left as needed—without moving forward or back, since that would mess up the focus—to get the spot positioned between the two arcs of light.

The outer arc (the blurrier one that is closer to the patient's temple) is the corneal reflection. It will almost always be outside the box, which is okay.

The inner arc (the sharper one that seems to be inside the pupil, and is closest to the patient's nose) is the lens reflection.

Both the focused solitary spot and the lens reflection arc should be within the box. In addition, the spot should be close to this arc—about one spot's size away—but without touching.

Have the patient blink a time or two, then push the joystick button. The computer takes five quick measurements and averages them for you.

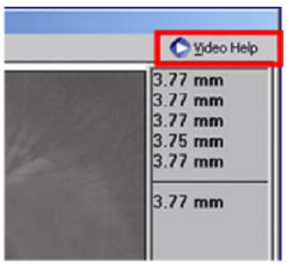
4. Make a mental note of what the number is, get refocused and realigned, then try the measurement again to see if you get a similar number. You do not have to delete the original set of numbers…simply push the joystick button again and it will overwrite what was there before.

If your new measurement is within 0.10 mm of your original number, you're okay to proceed to the next measurement—using White-to-White Mode. Just press the space bar to advance to that mode.

If your new measurement is more than 0.10 mm off, keep on performing the measurements until you are able to get consistent numbers.

☞ Important Note: This test uses a bright light. Be sure to warn the patient of this. Remind them to look at the light inside the instrument, not at the light coming from the side. Also, needless to say, you'll want to be as quick and efficient at this test as possible, to minimize patient discomfort (and subsequent lack of cooperation!)

New with version 5 software: ACD Measurement Adjustment Aid



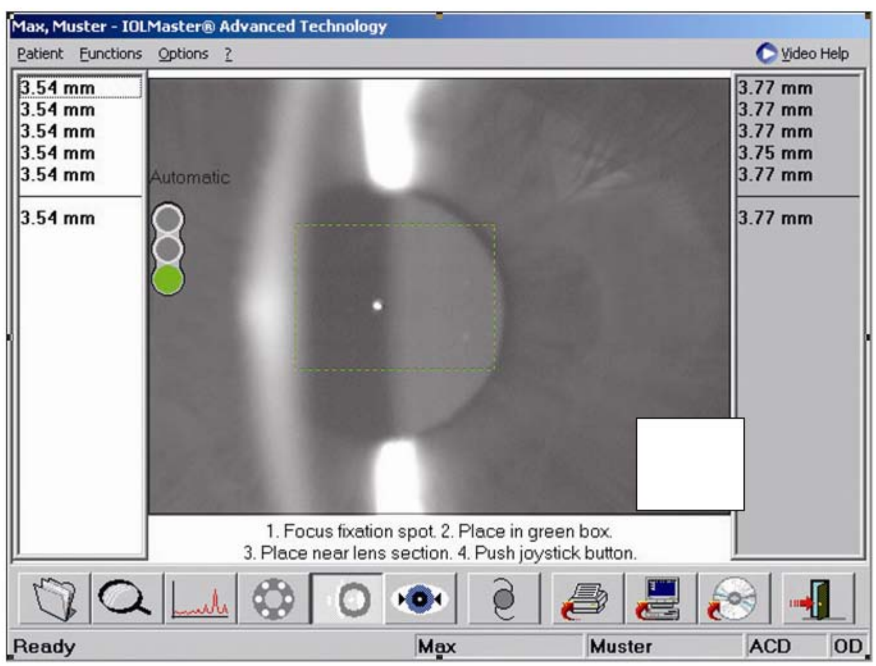
By clicking on the Video Help button in the upper right corner of the ACD Measurement window you can play a video illustrating the optimum measurement position.

☞ Note: There is no audio to accompany the video presentation.

A traffic light display helps you find the optimum ACD measurement position.

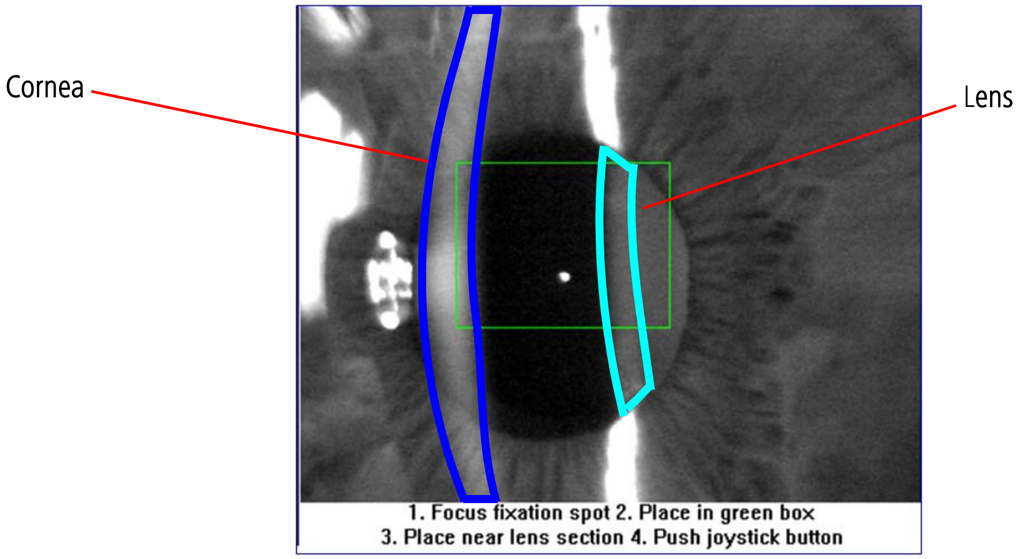
Please note: the ACD adjustment aid is monitoring the correct instrument alignment. Only when the optimum measurement position has been reached the traffic light will change from red to yellow and then from yellow to green. When the traffic light turns green, the instrument will allow ACD measurements.

The traffic light can be activated/deactivated under Options > Program Settings > Program.



Please make sure you are following the correct ACD alignment technique (as described in the User's Manual):

- Make sure the fixation point is in focus and inside the green box.
- The fixation point should be between the images of the cornea and the crystalline lens, closer to the lens (but not touching it).
- Avoid any bright reflections on the cornea.



☞ **Important Note: Because the ACD adjustment aid improves the quality of alignment you may get ACD readings that differ from readings obtained in manual mode. Differences smaller than 0.1mm are within the measurement tolerance and are no reason for concern. Generally, the ACD adjustment aid will increase the repeatability of your results.**

Adjustment Aid – Automatic Mode

Arrows will point in the direction the joystick should be moved in order to reach the best measurement position. In Automatic mode, the measurement can be activated by pressing the joystick button (Automatic activated) before the optimum measurement position has been reached. The measurement is then triggered automatically as soon as the traffic light turns green.

Important – Manual Mode

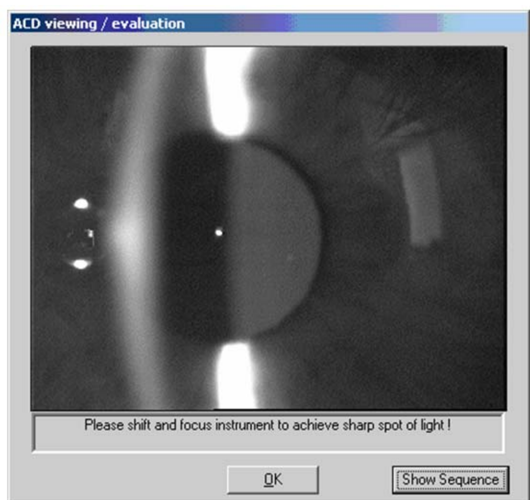
In some cases you may not be able to get the traffic light to turn green. In such cases, you can temporarily de-activate the automatic mode, allowing a measurement to be taken even when the light is yellow or red. To do this, press the <M> key—the Automatic mode display will disappear. Keep in mind: you will now have to manually ensure correct alignment (as described above). Press the <M> key to re-activate the automatic mode. The automatic mode will always be switched back on for the other eye and for every new patient.

Environmental Conditions

Avoid any light hitting the IOLMaster or the examined eye directly or from the side. The best results will be obtained when the examination room is slightly dimmed. Unfavorable room illumination will be indicated by a sun symbol. In addition, the slit illumination may be flashing on and off. In this case, additional dark exposures are being taken to improve the measurement results.

Error Messages

If the IOLMaster is not properly aligned, the images of the anterior lens and/or cornea cannot be evaluated. In this case the message "Measuring error" and a reference to the lacking or unrecognized image feature are displayed. In addition the first image that has caused a measuring error is displayed. With SHOW SEQUENCE all five images are displayed in succession for error analysis.The anterior chamber depth measurement may be repeated as often as desired.

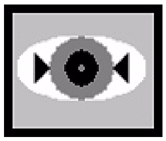


✘ Troubleshooting

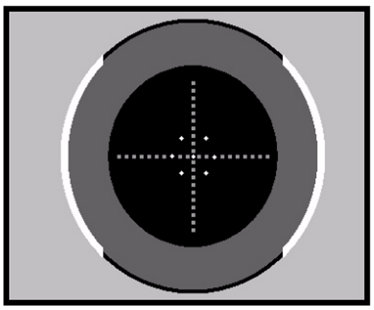
If you attempt an ACD measurement, and a message box appears asking you to manually type in the corneal curvature measurements, this means that you either somehow skipped measuring the K's, or more likely you measured them but did not notice that there was an "evaluation" instead of an average. Go back to the Corneal Curvature Mode and fix the problems, retesting the K's if necessary.

Part 4: White-to-White Measurement

White-to-White Mode



This is a measurement of the horizontal width of the visible iris, from the white scaler on one side to the white sclera on the other side. Certain more advanced lens calculation formulas need this measurement…but even if you are not using such formulas, this measurement can still be useful during various kinds of cataract surgery. If necessary, click the *White-to-White* icon to get to this mode.

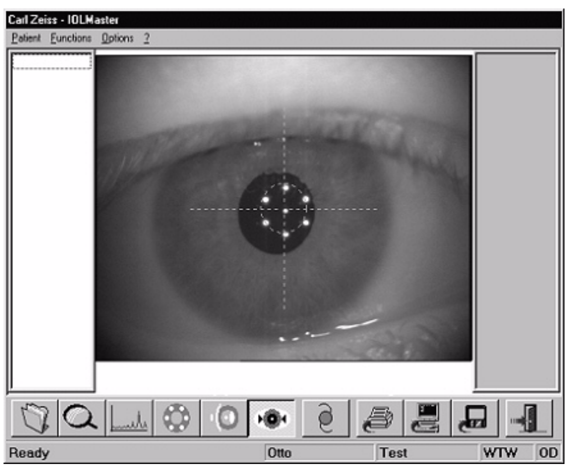


How Does It Work?

The computer takes a high-contrast photo of the eye, then detects the boundary between the paler sclera and the darker iris, and traces that boundary with a marker line at either side of the iris. Then the computer simply measures the longest distance between the two curved markers.

How to Perform the Test

When you first come to White-to-White Mode, you will see a screen that looks nearly identical to the first test screen, Overview Mode.

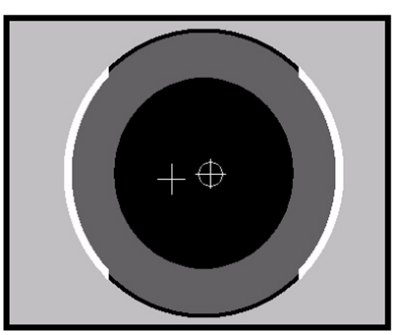


1.First, place the central spot of light in the center of the green circle target. Move the scanner left and right and rotate the joystick to move the scanner up and down, as needed.

2.Next, move the scanner back and forth and focus the flecks of the iris.

3.Have the patient open their lids wide, and push the joystick button. The computer takes a snapshot of the eye, and superimposes some graphics on it.

4.Take a look at the superimposed graphics. The most important graphics are two curved white lines, one on each side of the iris at the iris-sclera boundary. If the white lines are in the correct position, click OK below the snapshot. If the white lines are not in the right spot (too far into the darker iris, for instance), click Cancel to try again.



As for the other graphics, you may see this image in the center of the pupil. The circled cross-hair is the optical axis (the center point between the two edges of the iris). The plain cross-hairs is the visual axis (where the central dot used to be…the path along which the patients sees). Note that the visual axis will often be slightly off-center in the pupil, more toward the patient's nose, which is as it should be.

Once you have taken a measurement you like and saved it by clicking OK, take two more measurements and see if they all match up within 0.2 mm.

☞ **Important Note: Dimming the room lights can help this test by reducing glare from the eye and making the darker iris / lighter sclera boundary more "visible" to the system.**

<u>Moving on…to the other eye</u>

Now that you've taken all the desired measurements of one eye, pull the scanner back toward you and then slide it over so it's in front of the other eye. The computer will put you back in Overview Mode automatically. Simply repeat all the steps you just went through for the other eye.

When you've finished with both eyes, click on the printer icon at the bottom of your screen. This prints out all your measurements to keep in your chart.

New with version 5 software: IOLMaster Advanced Technology Plausibility Checks

In this feature, the computer checks the plausibility of your results. Plausibility checks of OD/OS AL and K values provide additional safety, especially on problematic eyes.

After axial length and keratometry measurements, the system checks the following conditions and gives appropriate warnings:

- AL < 22 mm = short eye!
- AL > 25 mm = long eye!
- R > 8,4 mm = very flat corneal curvature
- R < 7,2 mm = very steep corneal curvature!
- [R1 - R2] > 0,5 mm = high astigmatism!

If both eyes are measured the system will check consistency between both eyes:

- AL difference between OD and OS > 0.3 mm = Axial length of right eye is [X] mm smaller/larger than axial length of left eye—check plausibility!
- R / K difference between OD and OS > 0.2 mm / 1dpt = Mean corneal radius/K of right eye is [X] smaller/larger than mean corneal radius/K of left eye—check plausibility!

In all cases the following warning is shown:

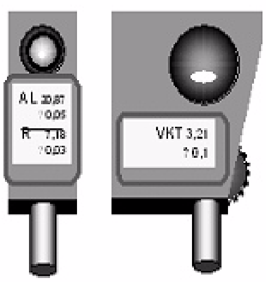
- Examine that no pathological changes are present!

This warning will also be added to the Remark field of the examined patient.

Part 5: Calibration Check

Best Practice: It is important to check the calibration of your IOLMaster at the beginning of every day you will be using the instrument. This confirms that the IOLMaster is operating properly, and helps ensure that the measurements you take will be accurate.

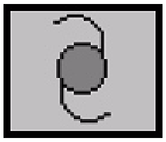
1. Get the calibration eye from its gray carrying case. The test eye looks like a small black box sitting on top of metal posts.
2. Place the metal pins at either side of the patient's chinrest, and insert the metal prongs of the calibration eye into the holes.
3. Rotate the black box so that the calibration eye, the side that looks like a small "spy camera" lens, is directly facing the IOLMaster lens.
4. Test the calibration eye as if it were a real patient. There may be a patient of the name Check Device already at the top of your list. Check the calibration under this name. If not, just enter a fake patient name like "Check Calibration" or something similar. Once in testing mode, select Test Eye from the Options menu (click Options > Test Eye). This way, the instrument knows you are in test eye mode. Next, measure the axial length and K's as if the "spy camera" lens of the black box were a real eye. To measure ACD, you need to rotate the calibration eye so that the round half-marble side is facing the IOLMaster. This should be done for both eyes. Just take the calibration eye out of the slit lamp, flip it around and measure the other eye.



   If you are using the WTW measurement on the IOLMaster, you should check its calibration as well. In this case, rotate the calibration eye again until the "grid" is facing the IOLMaster. When you select WTW while in test eye mode, instructions to check this measurement will appear on screen.
5. When you have measured axial length and K's, it's time to check the results. The calibration eye's axial length and corneal curvature is printed on the calibration eye, underneath the applicable lens. The axial length and K's you obtained on the test should match what is printed under the lens.

Helpful hint: On the calibration eye, the corneal curvature (K) measurements are given as a radius, rather than in diopters. However, if you print out the calibration results, it will print the K's in diopters as well as radius. It is a good idea to keep a binder or log of some kind to document your calibration checks, in case there is any reason to refer to it later. Alternatively, if you want to change the measurement units from diopters to radius temporarily, select Program Settings from the Options menu (click Options > Program Settings), and then select the Radius option.

So...What Now?



Now it's time to calculate which lens will be needed for surgery. Proceed to IOL Calculation Mode by pressing the letter "I" on the keyboard, or click on the *IOL Calculation* icon. See Chapter (5) Lens Calculations for details.

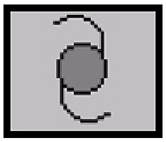
Please refer to Chapter (5) to learn about lens calculations and how to perform them. You'll see that many lens calculation formulas—such as the Hoffer Q, the Holliday, and the SRK/T—only require the axial length and corneal curvature measurements. However, there are some more complex formulas—such as the Haigis and the Holliday II—that require anterior chamber depth and white-to-white measurements.

(5) Lens Calculations

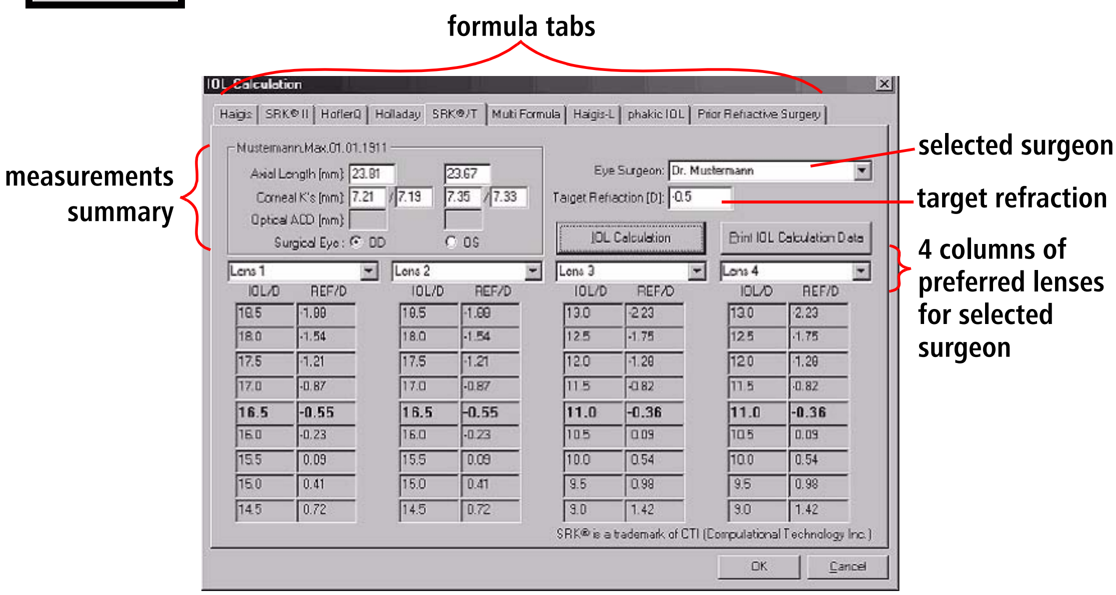
Now that you have acquired measurements of your patient's eyes, you can use them to determine what IOL power your patient needs to have the best possible post-operative vision.

☞ **Important Note: This chapter assumes your IOLMaster system has the surgeons' names and their favorite lens implants already programmed into the computer. If the surgeons and lenses are not yet entered, refer to Chapter (2) for instructions to do so.**

Lens Calculation Mode



After you have completed measuring both eyes, you can activate the IOL Calculation Mode by pressing "I" on the keyboard or by clicking *IOL Calculation* icon. Note that pressing the space bar will not take you to this mode.



Summary Data

At the left side of the screen, you will see fields containing a summary of measurements for both eyes. If any number is grayed out, that means the particular formula you selected does not need that number.

- Axial Length – This is the average axial length number that appeared at the bottom of the list of measurements back in Axial Length Mode.
- K's – This is the average steepest and flattest K that appeared at the bottom of the list of measurements back in Keratometer Mode.

- ACD – This is the average anterior chamber depth that appeared at the bottom of the list of measurements back in ACD Mode.

☞ Note: WtW (white-to-white) does not appear here, since none of the formulas utilized by the IOLMaster need this measurement.

✘ Troubleshooting

If the number is missing entirely, that means that the test was somehow not done at all, or more likely that there was an "evaluation" instead of an average. So, what to do? First, note which measurement is missing and for which eye. Second, click Cancel at the bottom of the screen. Third, slide the scanner to the correct eye (to your left for the right eye, to your right for the left eye). Fourth, click on the appropriate icon or press the appropriate key (A=Axial Length, K=Cornea, D=AC.Depth). Fifth, fix the problem (delete bad numbers to get the average back, or take more measurements).

Note that the numbers that appear automatically in these fields are those acquired during the IOLMaster testing. You can, if you choose to, override the computer and type in axial length measurements, corneal curvature measurements, etc., from other sources. Simply click on the field that contains the numbers you wish to change; click at the end of the number to insert the blinking text cursor ("|") there, backspace over the number, and type in the new number.

☞ Important Note: While the computer will let you type in numbers from other sources, like axial lengths from contact biometry or K's from manual keratometers, this is not the recommended course of action. The lens constants you have entered have been modified to take into account the unique measurement capabilities of the IOLMaster. (These are discussed in Chapter (2)). If you enter numbers from other sources, the calculation formulas will not "know" that the numbers are from non-IOLMaster sources, and will calculate the results as if they were. **This may produce a significant and unexpected surprise outcome in post-operative refractions!**

Surgeon Specifications

On the right side of the screen you will see a field containing the surgeon's name. You can choose different surgeons, each of which can be pre-set to have different default lenses. Each time you power up the instrument this field will be blank; you have to select a surgeon's name by clicking on the down-arrow.

Just under the surgeon's name, you will see a Target Refraction field. This is the desired post-operative refraction you want your patient to have after cataract surgery and lens implantation. Typically, the target refraction is near 0.00. This will allow the patient to see as well as possible at a distance. The instrument calculates +1.00 to −1.00 diopters above and below the target refraction, so if you are looking for a result within this margin there is no need to change the target refraction. If you desire the target refraction to be outside this margin you will need to change the target refraction number.

☞ **Important Note: Please be aware that if you change the target refraction, it will not automatically return to any default value. It remains the same until you change it again. It is a good idea to double-check whether the target refraction is set where you want it each time you calculate a lens.**

The Lenses

At the bottom of the screen you will see four columns, each with the name of a lens implant at the top. These fields will be blank the first time you enter the lens calculation screen, or the first time you calculate a lens for a specific surgeon. When blank, click on each down-arrow to select 4 lenses that surgeon prefers. Note that these columns are not where lenses are added, but rather where already-entered lenses are selected. See Chapter (2) to add lenses for surgeons.

Formula Calculation Tabs

A row of tabs appears at the top of the screen, each one with the name of a different lens calculation formula. The first five tabs are single formulas that can be used to calculate lenses for patients who have not had prior refractive surgery. The last five tabs are for multi-formula calculations, patients who have had prior refractive surgery, or patients having phakic IOL surgery. All of these will be discussed in more detail later in the chapter.

How to calculate using one of the first five tabs

1. Click the tab of the formula you wish to use.
2. Select the surgeon who will be operating on this patient.
3. Check whether the target refraction is what you want it to be. If not, edit it to the desired target refraction for this patient.
4. In the four lens columns, make sure the selected lenses are those you want. If not, click the down-arrow and select the name of the lens you want in that column.

5. Click IOL Calculation to see the results on screen only; click Print IOL Calculation Data to see the results and also print them out.

☞ **Important Note: The screen only shows you one eye's results at a time. Under the summary data, click the OD (right eye) or OS (left eye) radio button to see the results for the other eye. When you print, both eyes' results appear on the same sheet of paper.**

Choosing a Formula

Choosing a formula is a medical decision; Carl Zeiss Meditec cannot recommend a certain formula. There is much literature available on selecting a formula and you are encouraged to investigate this before you make this important decision.

Dr. Warren Hill's website has a wealth of information on this subject available for you to research. For further details, go to www.doctor-hill.com.

Basic Formulas

The SRK/T, the Holladay, and the Hoffer-Q formulas are all commonly used and fairly straightforward formulas. These formulas require only the axial length and corneal curvature measurements; if you measure anterior chamber depth, for instance, the results will not be incorporated into the results.

Each of these three formulas allow for up to four different lenses to be calculated and printed out at the same time.

- SRK/T is a formula—sometimes called the "Theoretic Formula"—produced by Donald Sandars, M.D. You may find it useful for both medium (axial lengths between 22.5 mm and 26 mm) and long eyes (axial lengths over 26 mm), but not for short eyes (axial lengths less than 22.5 mm).

  Printouts using the SRK/T formula will list the lenses' A-constants. These A-constants are rarely, if ever, the same as the manufacturer's A-constants. Chapter (2) explains more about this.

- Holladay (that is, Holladay I) is a formula produced by Jack Holladay, M.D. You may find it useful for both medium (axial lengths between 22.5 mm and 26 mm) and long eyes (axial lengths over 26 mm), and it seems to handle short eyes (axial lengths below 22.5 mm) slightly better than SRK/T.

  Printouts using the Holladay formula will list the lenses' SF (surgeon factor) rather than a lens A-constant.

- Hoffer Q is a formula produced by Kenneth Hoffer, M.D. You may find it useful for both short (axial lengths less than 22.5 mm) and medium eyes (axial lengths between 22.5 mm and 26 mm), but that it does not handle long eyes (axial lengths over 26 mm) as well as the Holladay and SRK/T.

  Printouts using the Hoffer Q will list the lenses' pACD (personalized ACD constant) rather than a lens A-constant.

But What About SRK II?

SRK II is an older "linear regression" formula, which uses a lens A-constant and a simple mathematical equation.

However, the SRK II is really useful only on medium length eyes; the larger or smaller the eye, the more modifications have to be made to the A-constant, and even that does not always help. Surgeons who are used to the SRK II may wish to consider the SRK/T as an alternative.

Haigis Formula

Now that we've covered some of the other formulas, let's discuss the Haigis formula, created by Dr. Wolfgang Haigis.

It is the only formula on the IOLMaster (except for the Phakic IOL formula) that takes into account the ACD measurement. The Haigis formula uses the a0, a1, and a2 constants to take into account various aspects of the eye. This makes the Haigis formula potentially the most useful of all the formulas, able to correctly calculate for any length eye with varying positions of the crystalline lens.

However, because of the use of multiple constants, this formula should be optimized before it is used. The a1 and a2 constants can only be optimized by Dr. Hill or Dr. Haigis. For detailed instructions to do this, please see Chapter (6).

Printouts using the Haigis will list the lenses' a0, a1, and a2 constants rather than a lens A-constant.

The Multi Formula

Selecting the Multi Formula tab reverses the order of things—rather than having four lenses calculated under one formula type, you pick one lens and have that lens calculated with up to four separate formulas at the same time.

1. Choose the one lens that you want to calculate
2. Choose which formula you want in each of the four columns

3. Click on IOL Calculation and the Print

This is useful for practices that utilize mainly one type of lens for nearly every patient. Using the Multi Formula tab, the surgeon can compare what different formulas calculate for that one lens.

The Haigis-L Formula

This is a relatively new formula, a modified version of the Haigis formula, which is useful for calculating lenses for eyes that have had myopic LASIK surgery. Because the Haigis-L does not make use of corneal power to predict post-operative lens position, it is unaffected by the errors that other formulas make in this regard. Please research this formula further if you are interested in using it. Multiple papers are published on this formula.

In terms of performing the calculations and printing out the results, use this tab just like you would the regular Haigis formula.

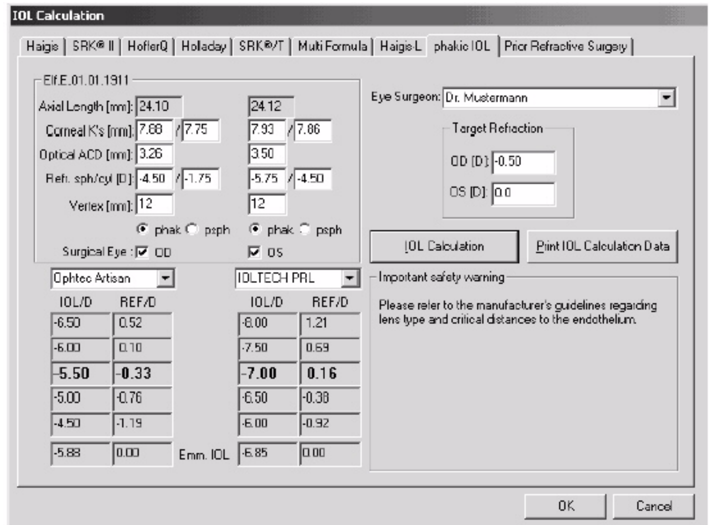
New with version 5 software: Haigis-L Formula now also for eyes which underwent hyperopic LVC

For post-refractive surgery patients, the system offers the Haigis L formula for eyes that have undergone myopic or hyperopic LVC (LASIK/PRK/LASEK).

The Phakic IOL Formula

Some patients would like to have LASIK to correct their nearsightedness, but cannot have the procedure, for example, because their cornea is too thin. Now there is an alternative—the Phakic IOL. Essentially, this procedure implants a synthetic lens in front of the natural crystalline lens.

With this tab you must manually type in the patient's current refraction in the measurements summary area to the left, even if you entered the refraction on the NEW PATIENT screen.



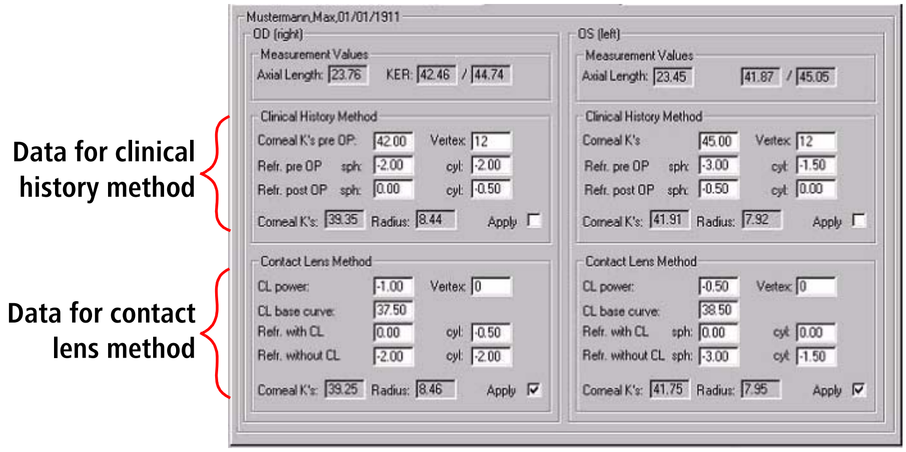
Unlike other formulas, your lens choices here are pre-set. You can choose from: Ophtec Artisan, AMO Verisyse, Staar ICL, and IOLTECH PRL.

Simply enter your current refraction and target refraction, pick your lens and calculate like any of the other formulas.

Prior Refractive Surgery

Though the IOLMaster offers the new Haigis-L formula, it is appropriate only for myopic LASIK surgery patients. The Prior Refractive Surgery tab provides two other methods for calculating IOLs for prior refractive surgery patients.

The Clinical History Method and the Contact Lens Method that are discussed in this section are not lens calculation formulas but more of a preparation for lens calculation. When this last tab is activated, there are two separate sets of data that can be entered for each eye—for the Clinical History Method (the top set of boxes) or for the Contact Lens Method (the bottom set of boxes).



☞ **Important Note: Carl Zeiss Meditec does not recommend any particular method for dealing with prior refractive surgery patients and their lens calculations. This is a medical decision, and these methods are merely provided for our customers' convenience.**

<u>Clinical History Method</u>

The Clinical History Method requires entering patient data from the patient's records from both before and after refractive surgery.

1. Manually enter the following data:

- Corneal K's Pre-OP – This is the average corneal curvature measurement (in diopters) from before the refractive procedure.
- Vertex – This is the distance from the back of the glass lens to the front of the cornea. In this case, it is the distance from the phoropter lens to the front of the cornea when the refractions were performed. Most phoropters have a mechanism by which an experienced examiner can determine the vertex distance. Whoever performed the patient's refraction for the refractive surgery work-up should have written the vertex down somewhere in the chart.
- Refr. Pre-OP – This is the sphere and the cylinder of the distance vision refraction from before the refractive surgery procedure (no axis required).
- Refr. Post-OP – This is the sphere and the cylinder of the distance vision refraction from after the refractive surgery procedure (no axis required).

☞ **Important Note: This post-refractive surgery refraction should not be the most recent refraction, as the presence of the cataract can unnaturally alter**

refraction results. Instead, these numbers should come from the refraction that was considered "stable" after the refractive surgery

2. Now that you've entered all of your data, select the Apply checkbox next to the data you've just entered.
3. Finally, click on the formula tab you normally would have used for this patient, and print out your results from there. You will notice that the corneal curvature measurements have been altered.

Contact Lens Method

The Contact Lens Method requires putting a rigid gas-permeable contact lens on your patient's eye and doing an over-refraction with the contact lens on (as well as entering other data).

☞ **Very important note: If you are doing all of your patient's testing on the same day, it is critical that you place the contact lens on the patient's eye only after all of the other testing is performed (including performing an uncorrected refraction on the phoropter). Otherwise you risk disturbing the corneal surface and/or the integrity of the tear film, and thus potentially distorting other measurements.**

1. Manually enter the following data:

- CL Power – This is the diopter strength of the contact lens you are using for this measurement.
- CL base curve – This is the curvature of the contact lens, which should be printed on the box it came in.
- Refr. with CL – This is the phoropter refraction (for distance vision) performed with the contact lens on. Remember, this measurement should be acquired last!
- Refr. without CL – This is the phoropter refraction (for distance vision) performed before the contact lens is put on.
- Vertex – This is the distance from the back of the glass lens to the front of the cornea. In this case, it is the distance from the phoropter lens to the front of the cornea when the refractions are performed. Most phoropters have a mechanism by which an experienced examiner can determine the vertex distance.

2. Now that you've entered all of your data, select the Apply checkbox next to the data you've just entered.

3. Finally, click on the formula tab that you normally would have used for this patient, and print out your results from there. You will notice that the corneal curvature measurements have been altered.

What About the Holladay II?

The Holladay II is a newer version of the original Holladay program. To use this formula, you must purchase it from Dr. Holladay and install it on a separate computer. It cannot be installed on the IOLMaster. Then you must transfer the measurements by CD, data cable, or manually. Please see Chapter (7) for basic instructions to export calculation data.

Should you choose to purchase the Holladay II program, you will be provided instructions on how best to utilize it from Dr. Holladay's organization.

☞ **Important Note: If you are using the Holladay II formula, you will not be calculating your lenses on the IOLMaster; therefore, there is no need to perform an optimization of your lens constants. The optimizing of lenses is discussed in the next chapter.**

What About Sulcus Lenses?

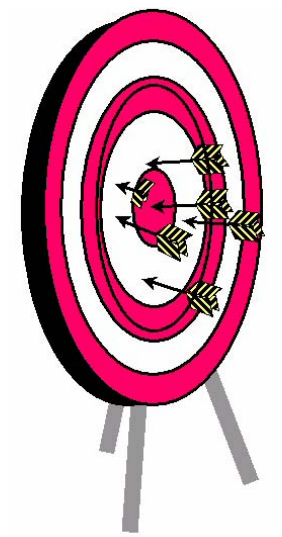
Sometimes the lens "bag" simply cannot be used to hold the implant. In this case, the lens may need to be placed in the ciliary sulcus—an area of the eye that is still behind the iris, but is about half a millimeter closer to the front of the eye than the standard implant position. Because the implant will be positioned closer to the cornea, a change must be made to its power to account for this.

(6) Optimizing Lenses

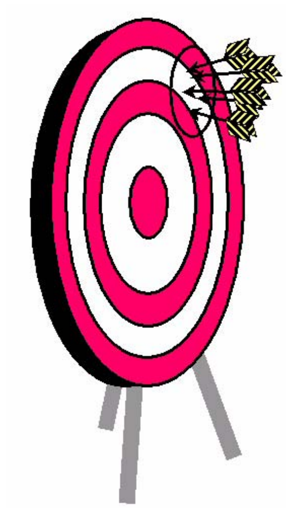
So, now you've had your IOLMaster for a few months. You've tested dozens of patients who have then had their eyes operated on, and you've had time to see how their stable post-operative refractions are turning out.

If all has gone well, most if not all of your patients' refractions will have turned out to be close to the target refraction. But chances are, while the surgical outcomes will be good, they will not be quite as excellent as the IOLMaster has the potential to provide. This is because every surgeon has a different surgical technique, which in turn will have a different impact on each type of lens.

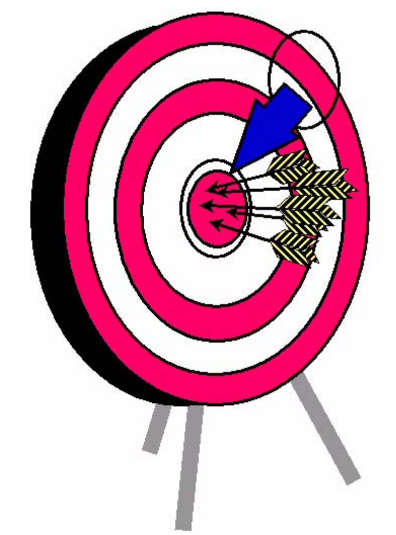
The good news is that the IOLMaster has a built-in program you can utilize to optimize and personalize surgical outcomes. This process involves manually entering your post-operative data into the IOLMaster, and allowing the optimization program to alter the lens constants so as to take into account each surgeon's technique. This in turn will improve outcomes of future surgeries by providing each surgeon with personalized lens constants. Below is an illustration that might help explain all of this.



Immersion ultrasound can provide good accuracy (clustered around bull's eye) but with low precision (large spread).



With un-personalized lens constants, IOLMaster can provide higher precision (tight cluster) but may initially have lower accuracy (clustered away from bull's eye).



Personalized lens constants provide high precision (tight cluster) and high accuracy (centered on bull's eye).

☞ Important Note: To avoid confusion, note that the terms "optimized" and "personalized" are used interchangeably in this chapter.

Sound complicated? It really isn't. Just follow this step-by-step process and you will be on your way.

Preparing for Optimization

Take these steps to prepare for optimization:

1. Check with the surgeon to make sure he or she wants you to perform the optimization.
2. Read the lens personalization section in your user manual.
3. Organize your data so that you are ready to fill out the Lens Constant Personalization Data Sheet. You will need to have the post-operative data organized in a particular way. Please see the following sections Surgeon and Lens Criteria and Patient Criteria.

Surgeon and Lens Criteria

- Make sure that the results are separated by doctor, then by lens.
  - For instance, you don't want the results from Dr. Jones' surgeries to be used when optimizing Dr. Smith's lenses, and you don't want the results from Dr. Smith's surgeries using Lens "A" to be used when optimizing Dr. Smith's Lens "B."
  - Therefore, you need a list of results that are only for Dr. Smith's Lens "A" patients, and another list of results that are only for Dr. Smith's Lens "B" patients, and another list of results that are only for Dr. Jones's Lens "A" patients, and so on.

Patient Criteria

Include the following types of patients:

- Patients with no prior refractive surgery
- Patients with no astigmatic relaxing incisions (LRI) at the time of their cataract surgery
- Patients with no macular pathology
- Patients with best corrected vision of at least 20/30

Don't include any "surprise results."

For each separate doctor, and for each separate doctor's individual lens, you will need the following information:

- The patient's name
- The eye that was operated on

- The power (in diopters) of the lens implant
- Stable post-op refraction. And that means *stable*—at the very least six weeks after the surgery, if not eight or more weeks.

You will need to have at least 10 such results per lens, per doctor. (The more the better; it is recommended to have at least 20.)

4. You are now ready to fill out the Personalization Data Sheet provided for you on the next page. Make copies of it so you can use it for each lens that you optimize.

IOLMaster™
Lens Constant Personalization Data Sheet

Surgeon:		IOL Make/Model[1]: (e.g., SN60AT)		IOL Location: (e.g., in bag)	

	Patient Name or ID	Sx Date	Sx Eye (R or L)	IOL Power[2] (D)	Post-Op Refraction[3]	Notes
1						
2						
3						
4						
5						
6						
7						
8						
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10						
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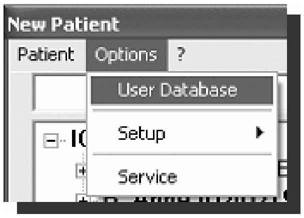
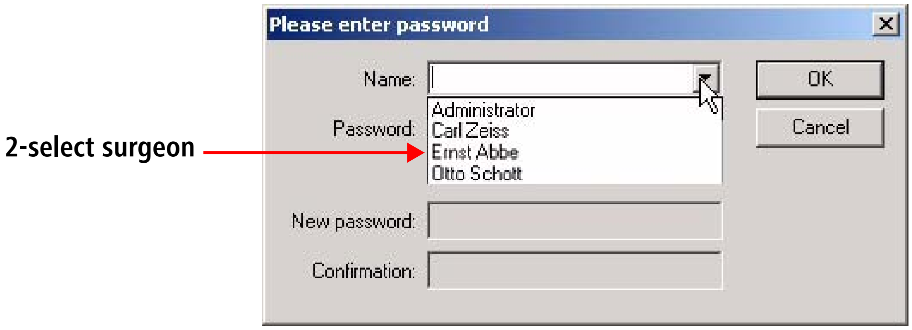
[1] Each Surgeon and IOL Brand/Model must have its own data sheet.
[2] IOL Power must be power listed on IOL packaging label in the chart for this patient/eye.
[3] Patient post-operative Visual Acuity must be stable and 20/30 or better.

Lets Get Started!

You will need to take all of the data you have gathered, put it on your Personalization Data Sheet and be in front of the IOLMaster. Follow these step by step instructions to enter your data into the optimization program.

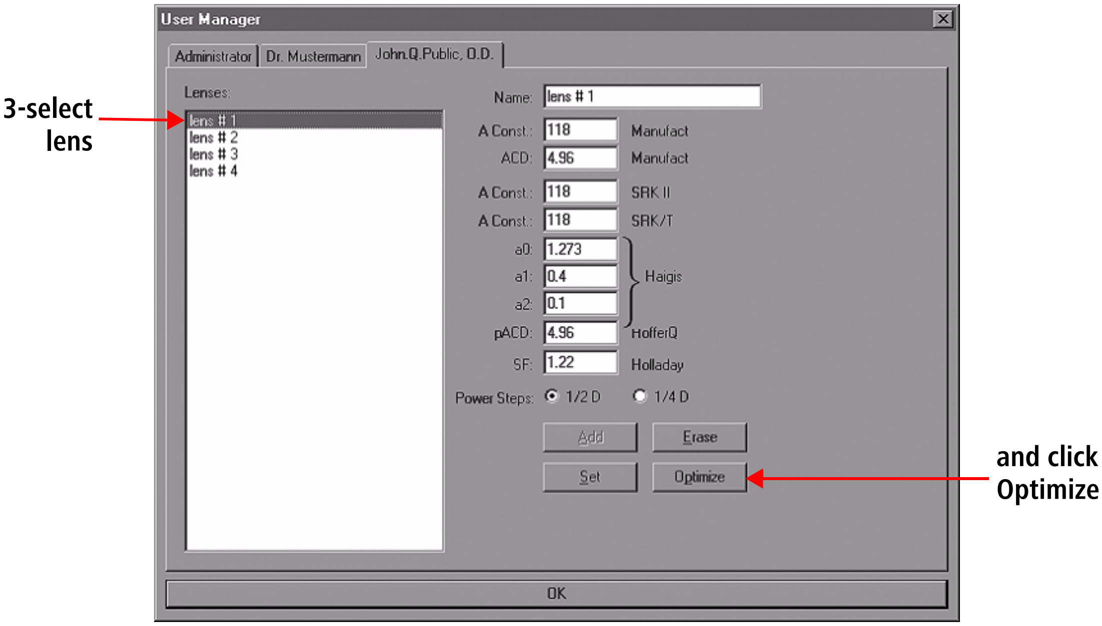


1. From the NEW PATIENT screen, select **User Database** from the **Options** menu (click **Options > User Database**). A dialog titled **Please enter password** appears.

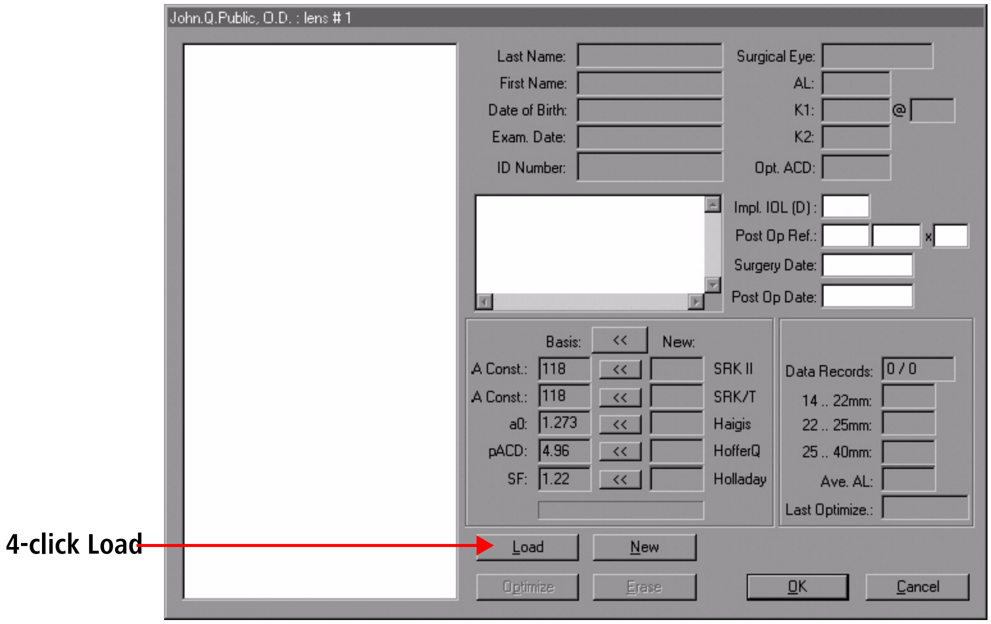


2. Click the down-arrow by the **Name** field, select the surgeon whose lens you are going to optimize and click **OK**.

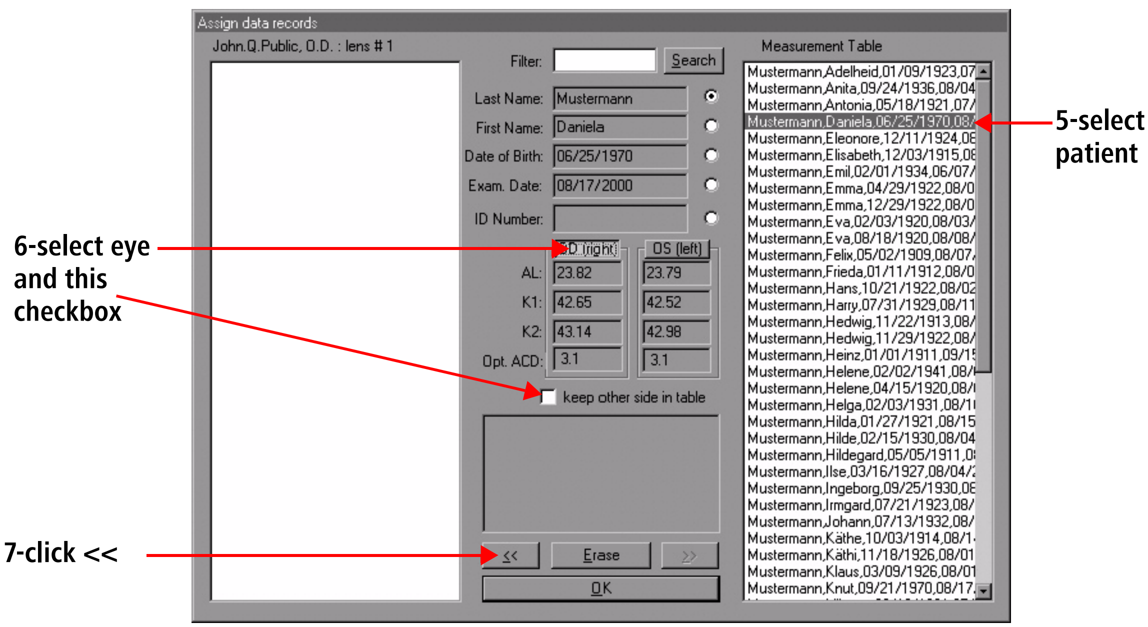
   You should see the tab for the selected surgeon listing the IOLs he or she uses, as below.



3. **Select the IOL** you are going to optimize, then click the **Optimize** button. The selected lens screen appears.



4. **Click the Load button.** You will now see a screen as shown below. The right side displays the list of all patients that you have measured on the IOLMaster.



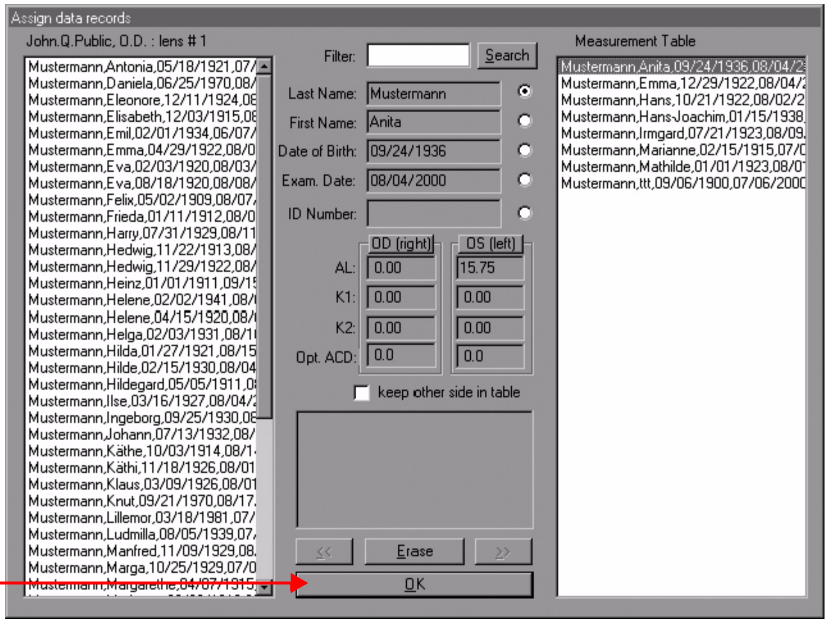
5. **Select the patient.** Make sure that patient's file has measurement data and is not filled with 0's (zeros). Check the data in the fields (labeled **AL** for axial length, **K** for corneal curvature, etc.). If the measurement data is filled with 0's, it means there was more than one file created for that patient. Therefore, that patient probably is listed more than once on the right side. Select another entry for that patient until you find the one with measurement data in it.

6. **Select the surgical eye** and select the checkbox labeled "**keep other side in table.**" This will keep the other eye available in the right-hand list for later use.
7. **Click the left arrow << button** at lower left to transfer the data file for the selected eye over to the left side of the screen.

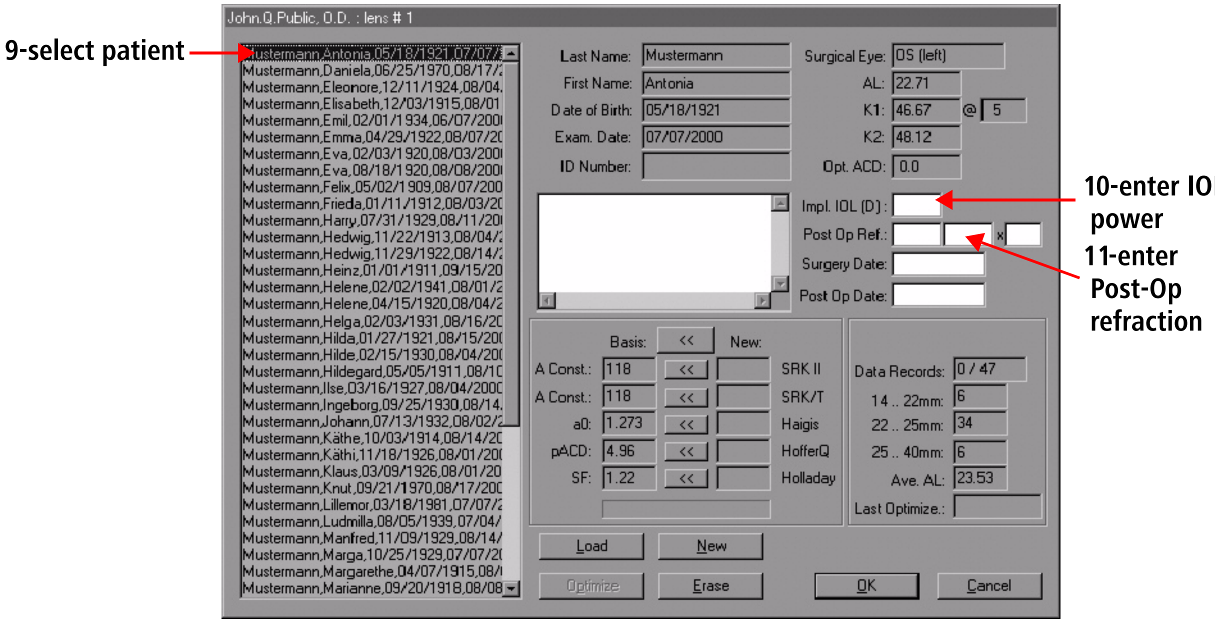
Repeat steps 5. through 7. for all desired patients implanted with this IOL type. Note that you must transfer separately each patient's opposite eye. A minimum of 10 entries is required for optimization, but at least 20 is preferable.

Once you have selected all the patients for this lens type, you will see them listed on the left side of your screen as shown below. You are ready to proceed to the next set of steps.

8-click OK



8. Click **OK.** The next screen looks as shown below.



9. Select a patient.

10. Enter diopter power of implanted IOL.

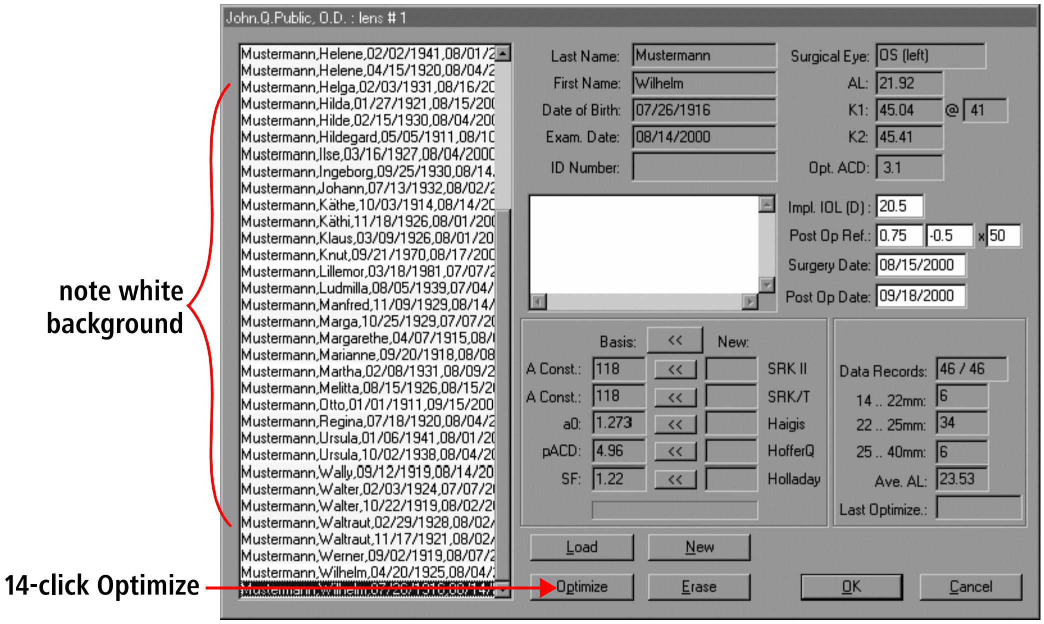
11. Enter post-operative refraction (the dates are optional).

12. Repeat steps **9.** through **11.** until data has been entered for each patient.

You will notice that as you enter patient data the background color behind the patient names will change from red to yellow or white. The colors have the following meanings.

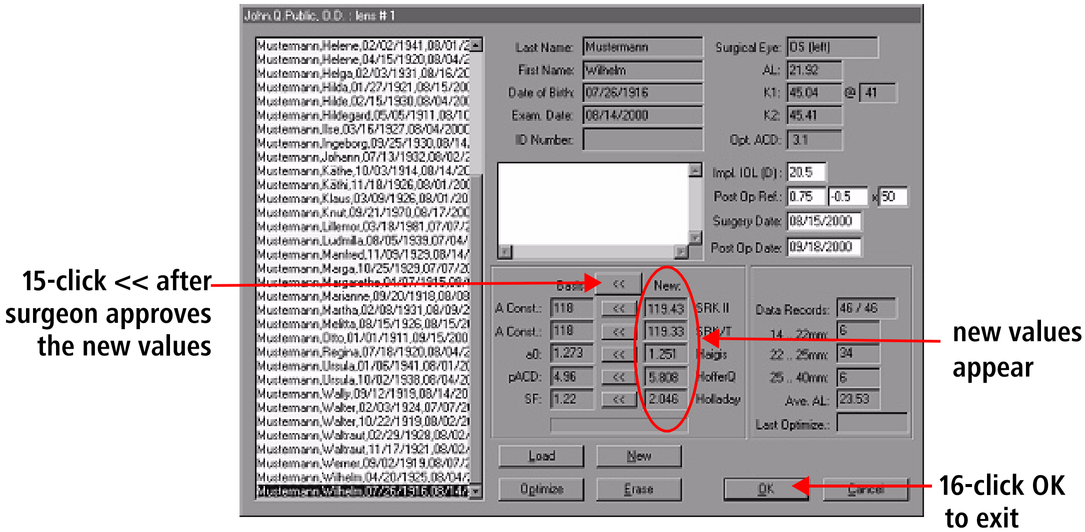
- Red: Patient is missing the IOL power and postoperative data.
- Yellow: No ACD values were measured for that patient, which means that the a0 constant for the Haigis formula will not be optimized. (Please see information about optimizing the Haigis formula later in this chapter)
- White: All measurements were done and data is available for optimization.

13. Make sure all data has been inputted for each patient on the left side of the screen.



14.**Click Optimize.** You will see a blue progress bar going across your screen while the instrument is calculating your new lens constants.

When it is finished calculating the new lens constant values it will display those new numbers in the **New** column near the center. If there are dashes in any or all of the fields, this means you need to add more patients to the optimization, then press **Optimize** again. **Evaluate the new proposed lens constant numbers, and show to the surgeon.**



15.**If these numbers are acceptable to the surgeon, click the << button** between the **New** and the **Basis** column headings. These new values now become your current lens constants. It is important that the surgeon is aware of this because the surgical outcomes will be affected. These optimized numbers will be closer to the target refraction, and if the surgeon has been using a “fudge factor,” that may no longer be necessary.

☞ **Important Note: This transfer of constants is permanent! You may want to consider writing down the old “Basis” numbers on a piece of paper before making the transfer.**

16. Click OK to exit the optimization program.

Congratulations! You’ve just optimized your first lens. Repeat all of these steps for each lens that has at least ten qualifying eyes, but remember: we recommend that you have at least twenty qualifying eyes from the same doctor’s surgery.

Remember that optimization isn’t a one-time event. We recommend that you continually add to your optimization database and update the constants.

Optimizing the Haigis Formula

The Haigis formula is unique in that it has three separate constants, a0, a1, and a2. The a0 constant is much like any other formula’s constant, but the a1 and a2 constants are different: they are tied directly to the measured anterior chamber depth (for a1) and axial length (for a2). Because of this, only the a0 constant will be optimized by means of entering post-operative data. If you want to use the Haigis formula you will need to contact Dr. Hill or Dr. Haigis for their assistance in optimizing a1 and a2.

For detailed instructions on collecting this data for submission, please refer to Dr. Hill’s website, specifically:

www.doctor-hill.com/physicians/download.htm

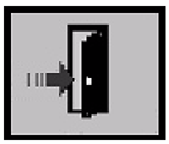
Now What?

After your lenses have been optimized, back them up! That way, if something ever happened to your hard drive, all that hard work won’t have gone to waste. Refer to the next chapter for steps on backing up the lenses.

(7) Data Management

Proper Shutdown

First, before you can manage your data, you have to make sure your data is not accidentally lost. Unfortunately this can happen with the IOLMaster—as it can with any computer—if there is a sudden fluctuation or interruption in the power supply.



A common interruption to the power supply results from improperly shutting down the IOLMaster. To exit properly, click the *Exit* icon at lower right of the NEW PATIENT screen. Although exiting from the NEW PATIENT screen is recommended, the *Exit* icon is also available from the measurement screen, and the IOLMaster can be shut down from that screen too. When the system asks if you're sure you want to shut down, click Yes. When it says it's safe to turn off the power, then and only then should you switch off the main power using the on/off switch on the side. (Even then, the computer may take its time completing the shutdown process; your screen may stay lit for a few extra seconds even after the switch is turned off).

If you simply turn the unit off at the switch (or turn off the power strip, or unplug the power cord, etc.) without going through the shutdown steps, you run the risk of losing patient data. The computer has some built-in safety mechanisms to help prevent this; it automatically attempts a proper shut down even if you turn it off at the switch—but why take the chance?

Worse yet, if power is interrupted by switching off a power strip or unplugging it from the wall, the risk of losing patient data is huge. So, in short, do yourself a favor and shut down properly.

Helpful hint: If your electrical infrastructure is prone to interruptions like flickers, brown-outs and black-outs, consider getting a UPS (Uninterruptible Power Supply). It is hardware about the size of a car battery, with several plug-in sockets for power cords. The UPS plugs into the wall to keep its battery charged. The IOLMaster plugs into the UPS and draws power through it. The UPS maintains a steady energy flow, smoothing out partial and temporary interruptions to the wall power, and if there is a blackout, the UPS battery provides several minutes for you to shut down the IOLMaster properly before the UPS battery gives out.

Lost Data

So, what happens if the patient data is lost due to an improper shutdown or sudden power interruption? You may see that a patient's name remains in the list, but when you click on the "+" by the name and then open a dated exam file below, it contains no measurements! What do you do?

If the data is truly lost, you cannot recover it directly; you can only retrieve it from a backup source, if you have one. However, if you need to print out a new lens calculation, there is a way:

1. First, get the printout of the patient's measurements from their chart.
2. Now click on the patient's name in the NEW PATIENT screen, and then click New.
3. When the test begins, skip doing the measurements and click on the *IOL Calculation* icon, or press "I."
4. Manually type in the patient data from the printout into the appropriate fields, and calculate lenses as you normally would.

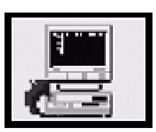
Export or Transfer Data

Data can be transferred in one of two ways: you can export data to removable media like a CD-RW or USB memory device, or you can transfer data directly to a networked computer (by cable). Either method must be executed from the patient measurement screen.

The Export Icon for CD or USB Export

From the measurement screen, click the *Export* icon or press the "X" key on the keyboard and the current data will be exported in a text file to either a CD or a USB memory device. The text format will conform to the export settings you select through the Program Settings menu.

The Send or Transmit Icon for Direct Transfer



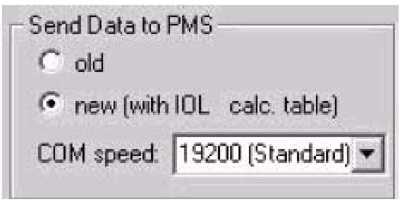
From the measurement screen, click the *Send* (or *Transmit*) icon or press the "S" key on the keyboard and the current data will be sent in a text file to a networked computer. The IOLMaster and the target computer must have been configured to communicate. The text format will conform to the selected export settings.

☞ Note: You must have the "Option B" software installed on the receiving PC, so that it can recognize the data it will be receiving from your IOLMaster. Also note that, although the IOLMaster has an Ethernet port, it does not communicate with Option B software through the Ethernet port, but through the ***serial*** port.

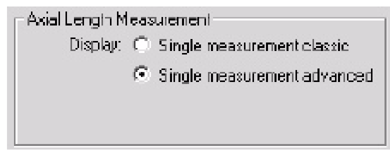
Export or Send (Transmit) Settings

It is important to make sure you have all of the export settings correctly set, or you may experience problems with the export or send procedure. Follow the next few steps to complete this process.

1. To access the export settings on the IOLMaster, select Program Settings from the Options menu, then select Export Settings (click Options > Program. Settings > Export Settings).

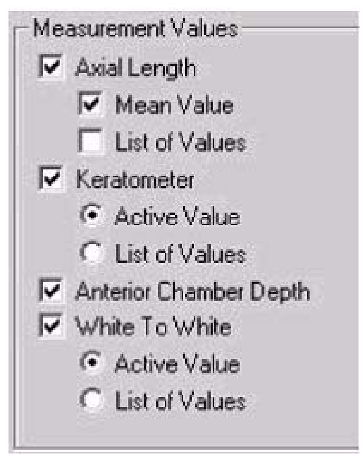


2. In the area named Send data to PMS, select the radio button for the appropriate version of export—old or new. You will most likely choose the new option, since the old option is primarily for software versions 1 and 2.
3. In the Axial Length Measurement area, you can select which type of axial length measurement to transfer.

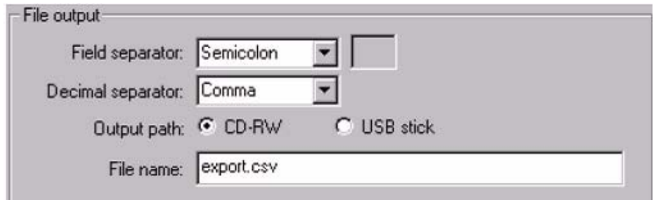


You will most likely select Single measurement advanced, since more information is transferred this way.

4. Choose what patient info you want transfer with your measurements.
5. Choose the measurement values you want to transfer. Unless you have a specific reason to do otherwise, select all four—Axial Length, Keratometer, Anterior Chamber Depth, and White to White.



6. Click on the Export tab and choose the desired options. Primarily, you will be selecting whether you are exporting to a CD or USB device, and what you wish the name of the exported file to be. If you are exporting to a specific program on another PC, be sure to consult that program's instructions to see if it requires these options to be configured in a certain way.



Holladay II Consultant

One common reason customers want to export their measurement data is because they are using the Holladay II Consultant. You can export measurement data as a text file from the IOLMaster onto the Holladay II Consultant program via removable media (CD or USB device) or serial port.

It is important that you contact Dr. Holladay's company in order to set up the Holladay II Consultant program so that it can receive the data from the IOLMaster. They are better equipped to handle questions on how to set up their program. The Holladay II Consultant program is a product of Jack T. Holladay, M.D. and is not affiliated with Carl Zeiss Meditec.

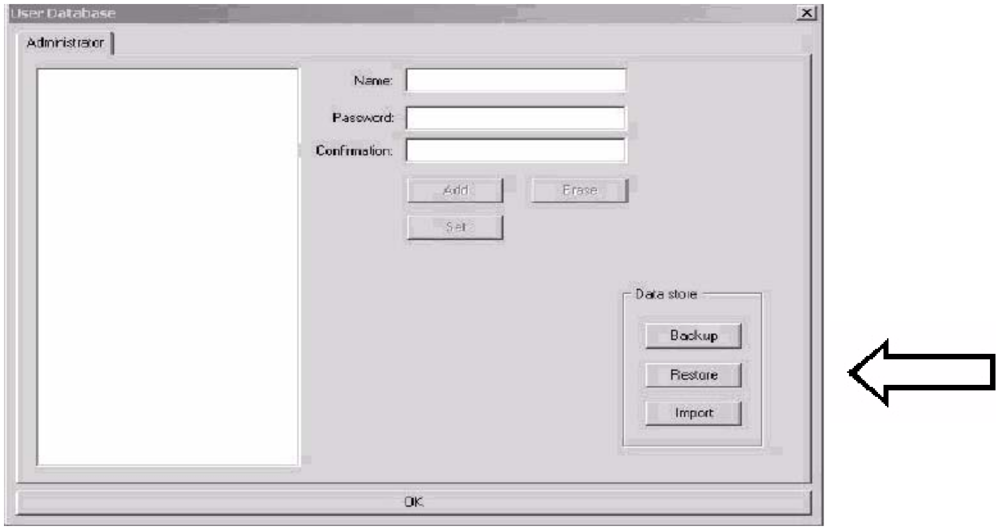
Backing Up Surgeon and Lens Data

It is a good idea to backup your surgeon information as well as their lens implant information. This is especially important after an optimization has been completed.

To complete this process follow the next few steps:

1. Click on Options, then User Database.
2. In the Name field, click the down-arrow and select Administrator. You will now be on the Administrator tab, and should see a list of surgeon names on the left side.

3. Click **Backup** and insert a blank, UDF-formatted CD-RW in the drive or a USB memory stick in a USB port. (Note: Two formatted CD-RWs are included in your IOLMaster accessory kit. If you don't have these, you can format (UDF) a CD-RW on another PC, not on the IOLMaster).



Restore

If you have lost the surgeon and lens information for any reason, you can simply insert the CD-RW or USB with this information on it and select **Restore**.

Import

The use of the import function is discussed in Chapter (2).

Finding All of This a Little Confusing?

You are not alone. It might be helpful to know that most customers don't use the export functions as a way to backup their data, mostly because the data is stored in an easily accessible form on the NEW PATIENT screen for up to 365 days, and a summary of the data is stored nearly indefinitely in the list of patients accessed for the Optimization function.

Furthermore, copies of the measurements should be kept in the patient's record to serve as a backup (akin to keeping printouts of ultrasound A-scans in the records).

As described earlier in the Lost Data section (see page 7-1), if you need to recalculate the IOL for a patient and for whatever reason the patient data is not on the instrument, you can recreate a data record and recalculate the IOL at anytime in the future, as long as you have the printout with the measurements on it.

For more in depth information on the export/transmit process, please read the appropriate section of the user manual, and if you need further assistance, please contact Carl Zeiss Meditec technical support at 1-800-341-6968.

☞ **Important Note: If your questions involve networking and/or computer interface issues, you will need to have your company's IT specialist contact technical support directly, to insure proper and effective communication.**

(8) Frequently Asked Questions

I need more help than this guide or the user manual can provide. Who do I contact?

If you have a question about the manual operation of your system (how to test an eye, how to print results, how to enter a new lens, etc.) and you can wait about one business day for a reply, you should contact the Carl Zeiss Meditec trainer who provided your office with instruction.

If the question involves a problem with your system (the screen is frozen, it won't turn on, it won't network, etc.), or you have an urgent question about anything that simply cannot wait one business day for a reply, contact Customer Service at 800-341-6968, and follow the prompts to the Service department (at the time of this writing, pushing "2" as soon as the automated message begins will get you to Service).

If your question is clinical in nature, you can find a wealth of information on Dr. Warren Hill's website, www.doctor-hill.com.

How often should I check the calibration of my IOLMaster?

EVERY DAY! Or better stated, at the beginning of every day that you use the instrument.

What if my instrument is out of calibration?

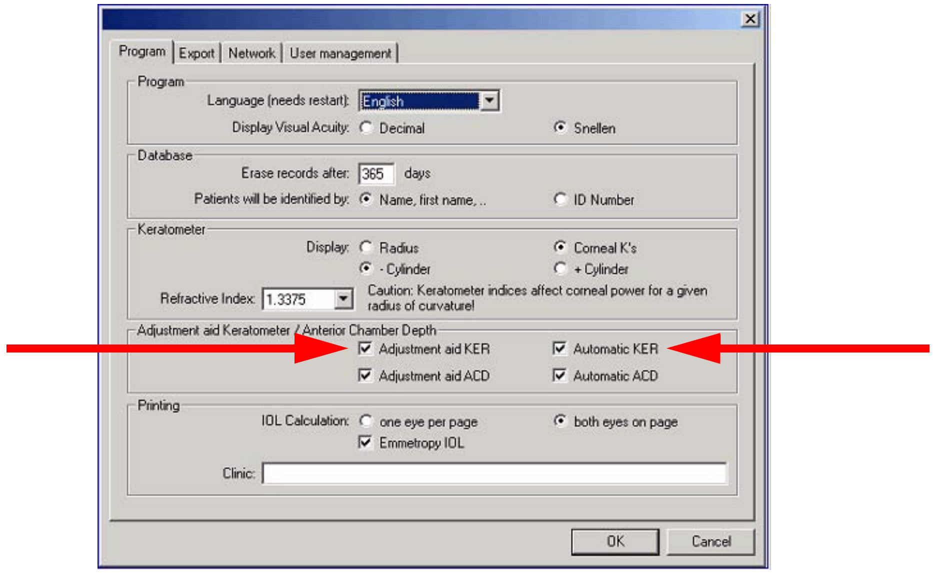
The first thing to do is clean your test eye. Clean by spraying a small amount of lens cleaner on a soft cloth or lens tissue and then wiping the calibration eye. Also make sure there is no bright fluorescent light or sunlight shining directly on the instrument. Re-test the calibration. If it is still not within calibration limits, call Customer Service at 1-800-341-6968 to report this. You should not test patients if your instrument is out of calibration. It may require a visit from your local field service engineer.

What if I lost my calibration test eye. Can I get another one?

You can order another one through the Carl Zeiss Meditec Customer Service department. Call 800-341-6968, choose the parts department option. It is part # Z 0000001046387. The cost is approximately $730.00.

How do I change how the K's are acquired?

If you want the Adjustment Aid ("traffic light") turned on or off, and/or you want the Automatic Mode (three scans acquired in rapid succession) turned on or off, select Program Settings from the Options menu (click Options > Program Settings) at the top of the screen. From here you can turn those features on or off. To activate automatic three-scan acquisition, you can also press the "M" key while in the Corneal Curvature (Keratometer) Mode.



What is the Keratometer Refractive Index? What should we set it at?

The keratometer index is the convergent factor that is used to change K's from radius of curvature to diopter K's. In the U.S., the keratometer index on most manual keratometers is 1.3375. Therefore, in the U.S., the IOLMaster will default to that number, but it is a good idea to double check it, especially after your instrument has been serviced. Note the figure above shows the keratometer index set at a different number. This is the number used in some other countries. It is not the correct number for the U.S. See the figure below for a correct refractive index setting.

My patient's data is missing!

First, was your patient in over a year ago? If so, the computer has probably deleted the file to make room for newer exams. The IOLMaster computer is not designed for mass-storage, so it will delete older files to make room for newer ones. You can check to see how long your system is set up to keep data: click

Options > Program Settings and then look at the Erase Records field. It should be set to 365 days (the maximum it can be). If it's not, change it to 365.

Second, is the data really missing, or have you simply tried to access it incorrectly? Be sure to click on the "+" by the patient's name, then click on the date they were in for their exam, then click Open. Clicking on the patient's name and then on New, or double-clicking on the patient's name will provide you with nothing in the way of data. These just add another visit date to that patient's file.

Third, don't forget that once you get into a certain patient's file you will be in Overview Mode, and you will need to click on one of the measurement modes to view the measurements that were taken that day.

Fourth, if you have done everything described above correctly, and there's still nothing there, then the data is, in fact, gone. Most likely there has been an interruption in the power supply (a flicker, a blackout, an improper shutdown, etc.), which has caused the computer to essentially have a partial "crash." Data lost in this way cannot be retrieved, but hopefully you still have the hardcopy you printed out at the time of the test. You may want to consider the use of an Uninterruptible Power Supply (UPS). If you are still losing data even with the use of a UPS, then the problem may lie within the IOLMaster itself. In this case, call Customer Service and explain that you are losing patient data even though you are shutting down properly and are using a UPS to prevent power interruptions. Read through Chapter (7) for more details.

☞ **Note: Occasionally there is a glitch which causes the data to be absent shortly after the scan is acquired, but it will be present again when the system is properly shut down and restarted. Contact Customer Service if this is the case.**

Why is the A-constant that prints out not the same as the manufacturer's A-constant?

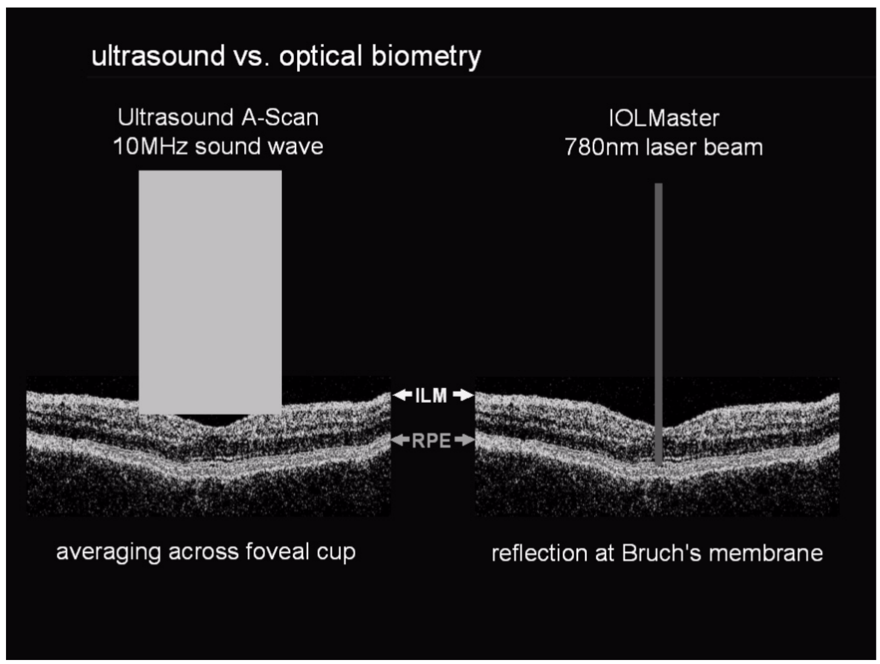
Because the IOLMaster measures slightly differently than contact ultrasound and manual keratometry, the A-constants for the lenses are often adjusted (usually a little higher) to account for this. So if the manufacturer's A-constant is 118.4, you may see a 118.7 for your SRK/T printout instead.

Furthermore, some of the formulas' printouts will not have an A-constant at all, but instead have an SF (for Holladay), a pACD (for Hoffer-Q), or a list of a0, a1, and a2 constants (for Haigis). Read through Chapter (2) for more details.

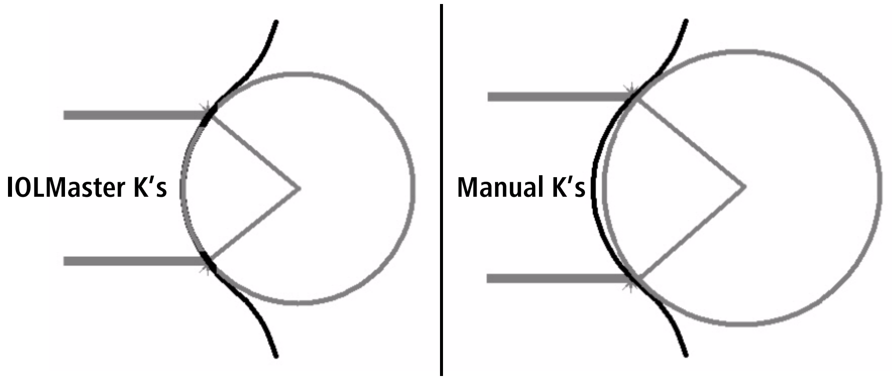
Why are the axial length and corneal curvatures different on the IOLMaster than on ultrasound and manual keratometry?

Regarding axial length: Unlike A-scan ultrasound, which reflects off the surface of the retina, the IOLMaster beam passes through the translucent surface of the retina and back further to the more opaque pigment layer. The computer corrects for this difference, but because everyone has different tissue thicknesses, results from the IOLMaster and immersion ultrasound may be slightly different.

In addition, the use of contact ultrasound will indent the cornea, thus decreasing the distance between the cornea and the retina and artificially shortening the axial length measured. Because of this, axial lengths measured on the IOLMaster are almost always longer than those obtained through contact ultrasound.



Regarding corneal curvature: First, manual keratometry measures the corneal curvature more peripherally—perhaps at 3.0 mm or 3.2 mm, depending on your manual system—while the IOLMaster measures the more relevant central curvature at 2.5 mm. Thus on a typical eye, IOLMaster K's will be slightly steeper than manual K's, while on a post-refractive eye, the IOLMaster K's may be slightly flatter.



Second, the IOLMaster determines curvature by measuring the relative position of six spots on the cornea, rather than the two mires of manual keratometry, thus providing more detail.

Third, if your IOLMaster is set to give curvature results in diopters rather than radius, the original radius is converted into diopters using the keratometry refractive index of 1.3375, which is not the same value as some other keratometry systems use.

The joystick controls seem so touchy. Is it broken?

Probably not. When you are performing a test, your screen is zoomed in very close to the patient's pupil, so even a little movement of the controls has a big impact on the pupil position. So be sure to hold the joystick firmly with one hand and the base of the scanner (just beside the joystick) with the other, and move the scanner using both hands together.

Do I do anything different when measuring a pseudophakic patient?

Yes, in two ways:

1. When in Axial Length Mode, select the appropriate pseudophakic IOL type from the **AL Settings** menu at the top of the screen. This must be done before calculating the IOL for that patient but not before measuring the patient. Please see What About Eyes That Have Already Had Surgery? (page 4-12) for more details about this.
2. Be cautious when measuring axial length on a pseudophakic patient. You will sometimes get two tall spikes, one unusually short and one at the axial length you would expect for that patient. The first unusually short spike is probably the instrument picking up a reflection from the IOL that is in the patient's eye. If this spike is equal or taller than the more "realistic" axial length, the

instrument will probably put the measurement cursor on that spike, causing the axial length measurement to be incorrect. The easiest and safest thing to do in this case is to delete that measurement and take more measurements. You may not be able to get rid of that short spike, but you should be able to get enough readings where that spike is shorter than the actual axial length.

Can I enter manual K's and/or other biometer's axial lengths into the lens calculation screen?

Well, technically yes, *but this is not recommended.* The reason it is not recommended is that, as Chapter (2) discusses, the lens constants you entered for the IOLMaster have been adjusted to account for the difference in how the IOLMaster measures. For this reason you would not want to use measurements from these other technologies in the IOLMaster, because the IOLMaster will calculate the IOL using the IOLMaster-adjusted lens constants, which would be incorrect in this case.

It is best to stick with the same technology, the IOLMaster, for all measurements, this way you don't have to worry about these issues.

What do I do if my printer stops working?

Printers are under warranty through Carl Zeiss Meditec for 30 days, and for 1 year with the printer company. If it is within the 30 day window, contact Customer Service at 1-800-341-6968. If it is past the 30 day window but still within the year, contact the printer company directly. If it is over a year, it may be best to purchase another printer. However, you should not purchase just any printer. To find out which printers are approved for use with the IOLMaster call Customer Service or check the Carl Zeiss Meditec website:

www.meditec.zeiss.com/iolmaster.

If you call, they will ask you for your IOLMaster serial # and give you a list of printers that have been tested to be compatible with your IOLMaster.

$50 US

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IOLMaster: A Practical Operation Guide

Specifications subject to change