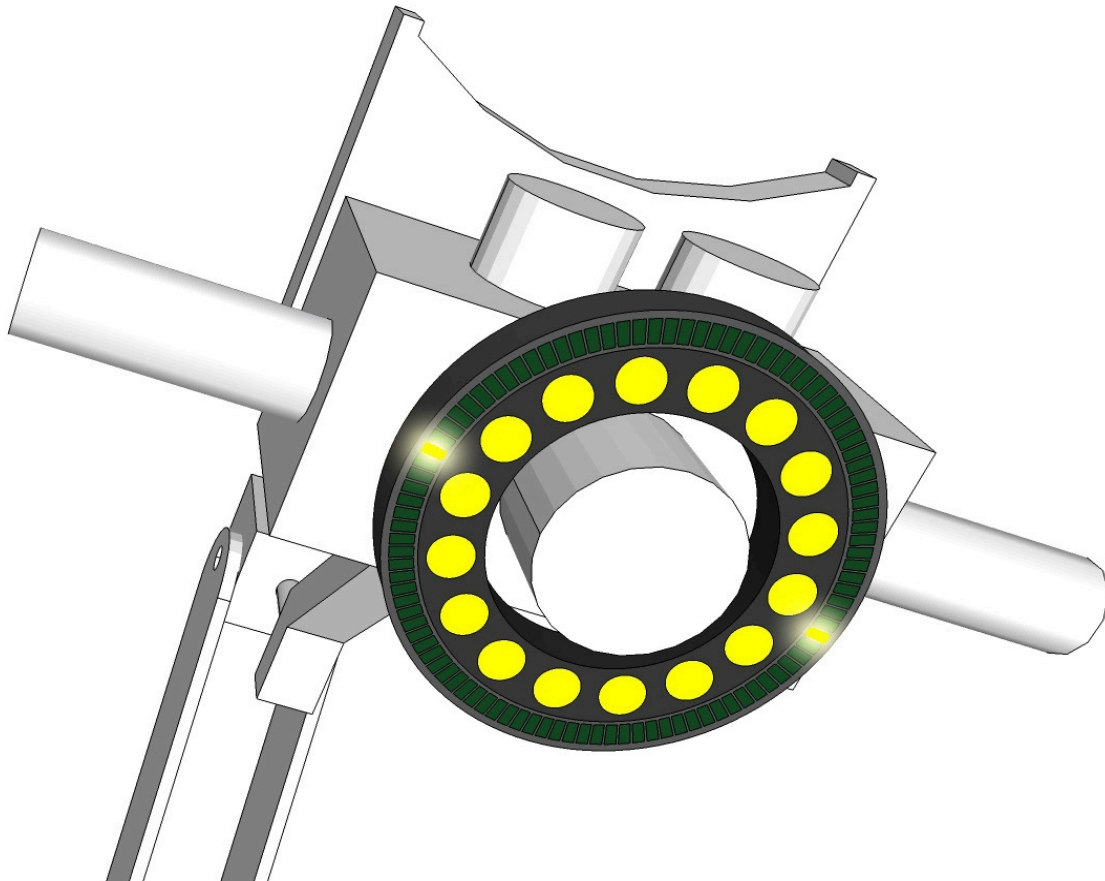




CHRONOS VISION

Your partner for vision based decisions



Surgery Guidance System for toric IOL Implantation

- ✓ Computer aided guidance system for cataract surgery
- ✓ Intraoperative axis determination and guidance
- ✓ Retrofitting capability to upgrade any surgical microscope
- ✓ Various visual guidance options
- ✓ Patient friendly, easy to use & cost-effective

MADE IN GERMANY

IOL Guidance

Medical background

Patients suffering from **cataract** often have to undergo an operation in which the lens is removed and replaced by an artificial lens implant. Nearly 30 % of those patients have an additional vision defect called **astigmatism**. Until quite recently this defect could not be taken into consideration and astigmatic patients get also a spherically-shaped intra ocular lens, called **IOL**, just like the patients without astigmatism. Meanwhile

progresses in IOL manufacturing make it possible to produce **toric IOLs** that consider a possible toricity of the cornea by being torical itself in order to compensate for the corneal asphericity. For optimum effect, the axis of a toric IOL has to be **properly aligned** with the axis of corneal astigmatism, since every degree by which the toric IOL axis misses the patient's axis of astigmatism reduces the optimum outcome by 3 %.

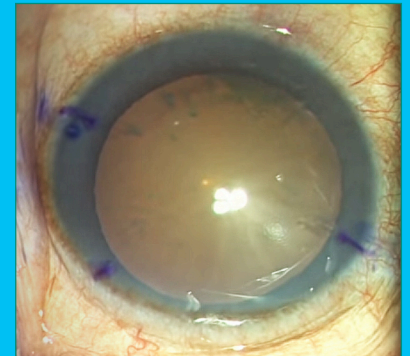
Motivation and challenge

During surgery, the question arises as to how the axis of astigmatism is aligned compared to the time of diagnosis, as additional head and eye rotations may have occurred between upright and supine positions during diagnosis and surgery. This torsion must therefore be determined in order to **correctly align the IOL axis with the astigmatism axis**. The majority of surgeons

use a manual technique to mark the desired toric lens direction. Some modern systems attempt to solve this problem by using image processing to determine the torsion between a current image from a microscope camera and a diagnostic image. The **main obstacles** to both methods are described in the following sections.

Inaccurate manual marking procedure

In many practices, doctors still manually mark the reference and astigmatism axes in a time-consuming manner using stamps and pens as a guide for the alignment of the toric IOL. The quality of the markings, which can be affected by various influences (inaccuracies when applying markings that are too thick, lack of patient cooperation, smearing and fading of the ink), is extremely important and has a direct impact on the surgical result: for every degree of deviation of the IOL axis, the desired effect decreases by 3 %. Therefore, with typical errors of 5°, a loss of effectiveness of 15 % must be expected.



Lack of vessels

The image illustrates the potential problem of not having enough corresponding scleral or limbal vessel features for an image processing-assisted matching process. While the diagnostic image has clear landmarks, almost no vessels can be found during surgery (e.g. due to conjunctival chemosis etc.). It can also happen that regions that have prominent scleral blood vessels during diagnosis get out of sight during surgery solely due to the orientation of the microscope camera and the aspect ratio of its images or a reduced field of view.

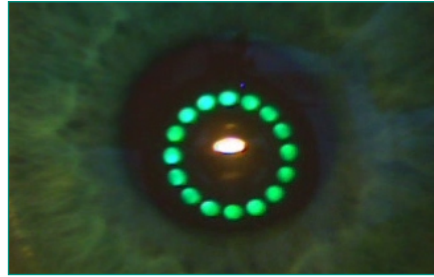
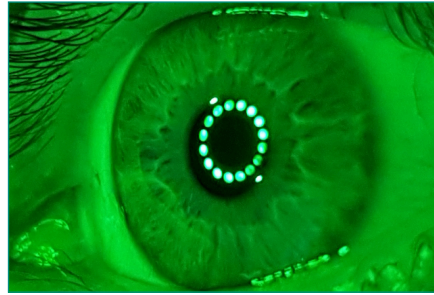
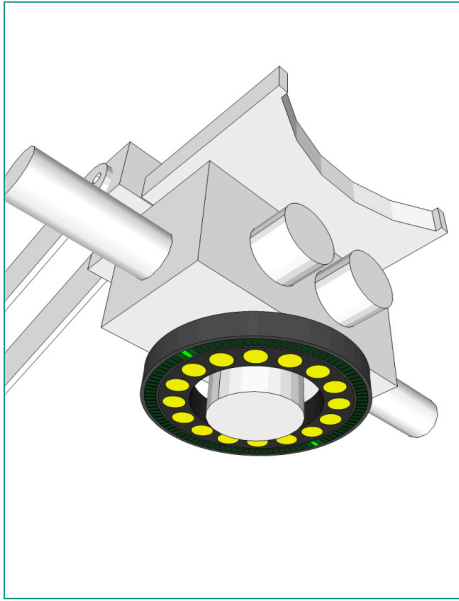
Hematomas

During lens fragmentation with a femtosecond laser, the eyeball must be fixed to avoid movement. This suction process can create scleral hematomas that partially cover the scleral vessels, causing the registration process in which image processing algorithms attempt to calculate torsion to fail.



CHRONOS VISION technology

To overcome the mentioned problems, the toric IOL guidance solution from CHRONOS VISION avoids any reference to images from diagnosis and instead performs a **new intraoperative measurement** of the axis of astigmatism while the patient is in surgical position.



Intraoperative measurement

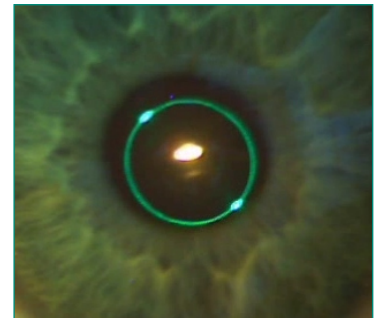
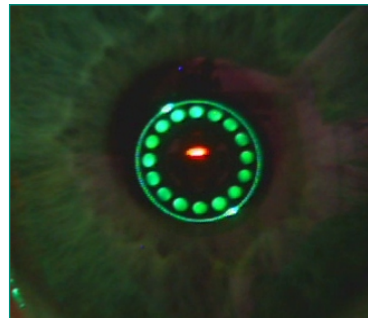
The measurement principle is quite the same as during diagnosis, i.e. a **ring of light sources** (measurement ring) mounted around the microscope lens is used to produce **corneal reflexes** which can be observed by using the microscope camera. Image processing algorithms will locate those reflexes in the camera image and infer the actual orientation of the **axis of astigmatism** based on the elliptical shape of their arrangement in real-time.

Integration and guidance options

The CHRONOS VISION system offers various possibilities to present the actual axis of astigmatism and/or the target orientation of the IOL to the surgeon:

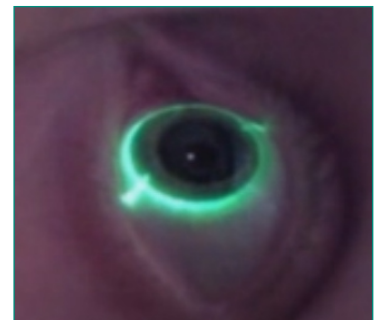
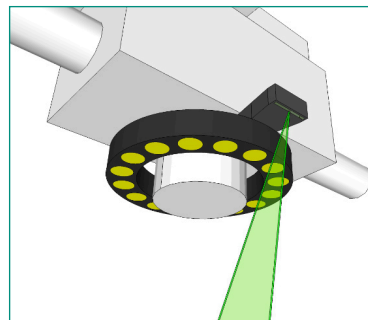
A Reflex ring

One of the visualization methods to indicate the measured axis of astigmatism is **reflection** based. An additional concentric ring of LEDs generates corneal reflexes whose virtual connecting line specifies the target orientation of the toric IOL and/or the measured axis of astigmatism.



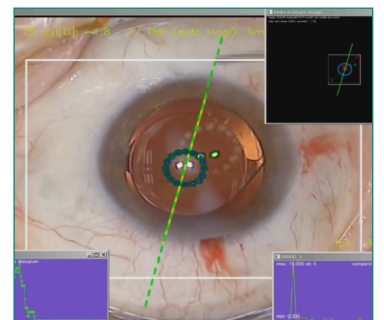
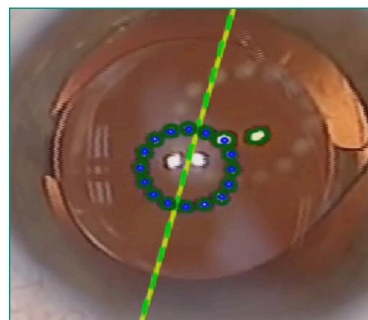
B Projection onto eye surface

As a further option a luminous lines denoting the patient's axis of astigmatism and/or the desired IOL orientation can be **externally projected** onto the eye. Eye tracking algorithms will ensure that the luminous lines appears always centered with respect to the limbus. In addition, various further overlays can be displayed such as incision markings.



C Injection into viewing field or external display

If the microscope is equipped with an **image injection module**, the intraoperatively measured axis of astigmatism, the desired IOL orientation plus additional information can be embedded virtually into the viewing area of the surgeon. Alternatively, an **external display** can be used to display all those relevant information to assist with IOL alignment.



Key features and advantages

Retrofitting capabilities

What makes this approach so attractive is the fact that all microscopes can be equipped, even subsequently, with a visualization and measurement unit eliminating the need to purchase a new and extremely costly guidance system, often tied to the use of certain lens brands and/or associated with a per-use payment.

Various visual guidance options

According to the surgeon's preferences, needs and existing equipment the visualization of the target toric axis orientation can be realized in different ways. If the practice or clinic already has a microscope with an image injection unit, then the embedded option C will be the method of choice.

Reliable and time saving

With the IOL guidance system from CHRONOS VISION, which can potentially be mounted on any microscope using appropriate adapters, the time-consuming, labor-intensive and often inaccurate marking procedure using stamps and pens is no longer necessary.

Cost-effective

The fact that no special diagnostic device is required for a reference image makes the system much more cost-effective than other system on the market.

Patient friendly and easy to use

The CHRONOS VISION system is not causing any type of discomfort, is straightforward to use and requires no training period.

No reduction of working area

In contrast to wavefront aberrometers the CHRONOS VISION system is lightweight and does not limit the surgeon's mobility.

Patented technology

The described technology of the surgery guidance system for toric IOL implantation from CHRONOS VISION is protected by patent.