# PENTACAM System's Overview: Understanding its Benefits

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Theodor Scheimpflug (1865 – 1911) is the pioneer of aerial mapping. He invented the aerial photogrammetry using numerous technical instruments for land surveying from the air. Scheimpflug took photos of the landscape from a balloon or a kite. The resulting oblique views could not be used directly for creating a map but had to be deskewed at first. For this purpose, he created a specific deskewing device which was completed in 1906. In 1907, he published his fundamental work "Die Herstellung von Karten und Plänen auf photographischem Wege"(The Making of Maps and Plans using Photography).

The rule on camera position resulting from it is of major significance for professional photography. It is always used in situations where it is desirable to display oblique views without distortions. Until today, this rule is of great importance, not only in architectural photography, but also for imaging and diagnostic examinations in ophthalmology: Object plane, lens plane and film plane have to intersect in imaginary extension in one common place so that the images of points with different distances from the camera are equally sharp. Recently, this 100-year-old aerial photogrammetry has been deployed again very up-to-date by the Internet portal Google Earth to produce undistorted images of landscapes and cities.

Images of the earth taken from a balloon or a satellite and images of the cornea have one thing in common: both objects to be photographed are curved and both need to be depicted without distortions. Corneal topography achieved this for images of the cornea in the early eighties, using computer-aided systems. A minor disadvantage of these topographs was and still is that in most cases a camera is placed in the centre of the imaging instruments so that, varying with the system type, a 1-2 mm large area is not measured but only calculated. However, this separately calculated area is the corneal center which is highly important for many applications. With moving slit lamp shots it is attempted to eliminate this disadvantage; however, despite of additional Placido's disks, they have other drawbacks. For example, they are very sensitive to the individual tear film. Today, all of these inadequacies have been overcome by the rotating Scheimpflug camera. Because of its special design and way of measuring, it scans the corneal center with the same precision as it does the peripheral parts, independent of the individual tear film.

## The Rotating Scheimpflug Camera - Pentacam

The Pentacam generates a real time image of the actual specific eye segmental. The system contains a rotating Scheimpflug camera that can create a precise, three-dimensional view of the anterior segment including the central cornea.

The Pentacam measures the anterior and posterior surfaces of the cornea by taking 50 single slit images in 2 seconds while it rotates around the eye from 0° to 180°. The system evaluates 500 measurement points from each slit image, totaling 25,000 true elevation points that create an exact 3-D image of the anterior segment. The device has two cameras, one in the center for controlling fixation, and one mounted on a rotating wheel to capture the slit images.

In the picture the start and stop point is shown, the known problem with the nose shadow as with topograhic measurements is no more evident. The period of time to take a complete examination of the anterior eye segmental is max 2 seconds for 50 single pictures. From every single picture 500 measurements points are evaluated, the maximum is 25.000 true elevation points. The 25.000 true elevation points are the basis to generate a exact 3-D model of the anterior eye.

A recent update with a high resolution camera (1380x1040 Mpixel) and 138.000 real data measurement was released in 2006 by Oculus, Germany.

## Measurement Data Representation

The topography and pachymetry of the entire anterior and posterior surface of the cornea from limbus to limbus are calculated and depicted. The topography is generated by a true elevation map, no curvature measurement (Placido).

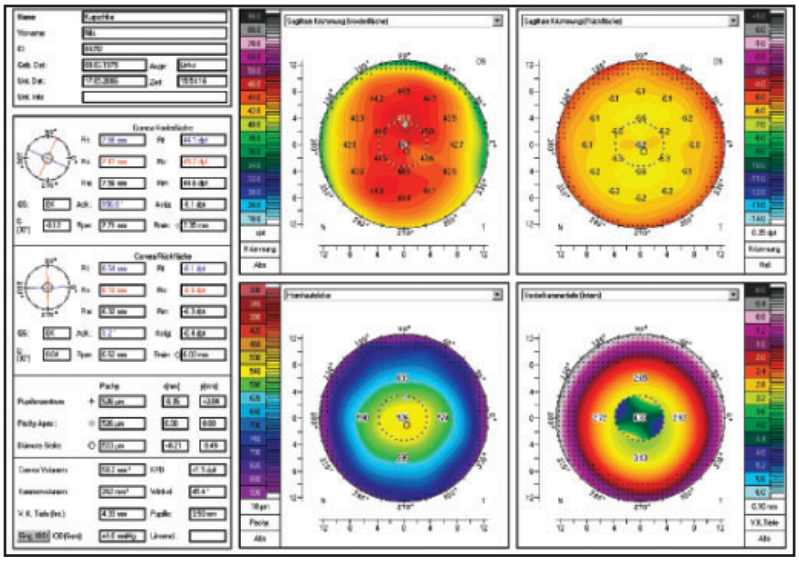
The analysis of the anterior eye segment includes a calculation of the chamber angle, chamber volume and chamber height and a manual measuring function at any location in the anterior chamber of the eye. In a moveable virtual eye, images of the anterior and posterior surface of the cornea, the iris and the anterior and posterior surface of the lens are generated.

## Color Maps – Corneal Topography

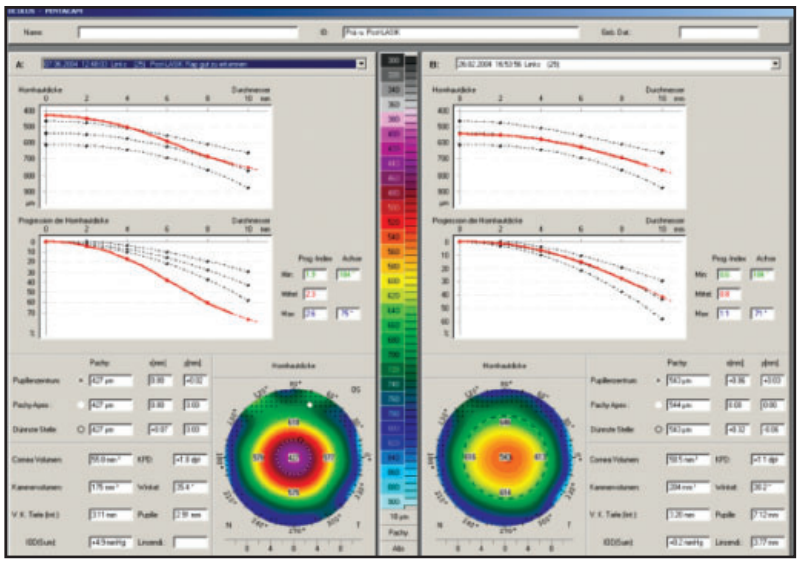
While on the left side the relevant data are represented numerically, the color maps can be depicted individually in the default settings. The left upper color map depicts the topographic anterior surface of the cornea, the right upper color map the posterior corneal surface. Using this example, the presence of a symmetrical astigmatism which cannot be determined with certainty in the anterior surface representation can be clearly demonstrated.

The left lower color map shows the distribution of corneal thickness – the pachymetry. The right lower color map shows the corresponding anterior chamber depth.

We use this representation of the measurement data together with the patient's refraction data for the selection of refractive surgery: corneal or lens refractive surgery.



*Corneal Topography*



*The Pachymetry Map*

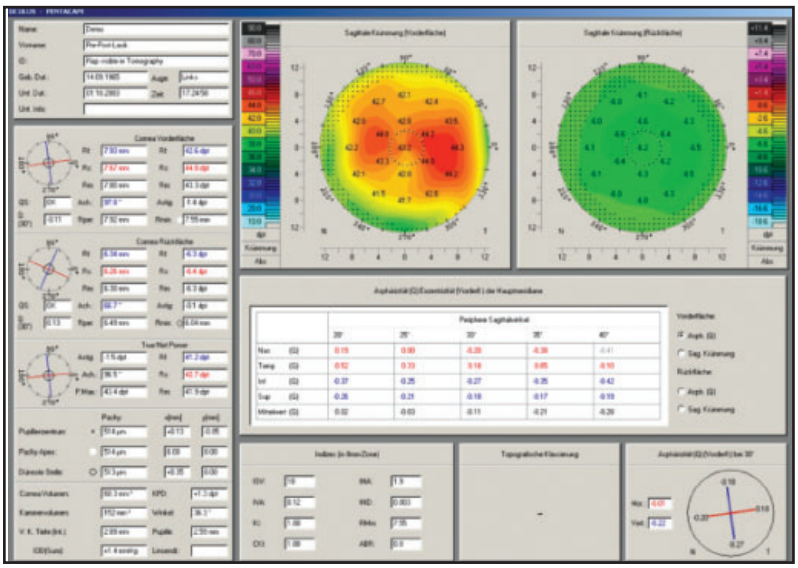
## The Pachymetry Map

The representation of the measured pachymetry data immediately clarifies the question regarding corneal refractive surgery. The left picture shows clearly the deviation from the normal corneal curves, while on the right map the measured red line follows exactly the normal curve.

## Comparative Topographical Representation Together with the Q-factor

These pre- and postoperative graphic representations after Lasik treatment are of advantage in problem cases.

The additional information provided by the Q factor - the mathematical expression about corneal asphericity – continues to gain importance in artificial lens selection in cataract surgery, because the new aspheric intraocular lenses have different Q-values.



*Comparative Topographical Representation*



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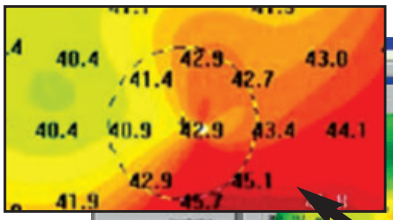
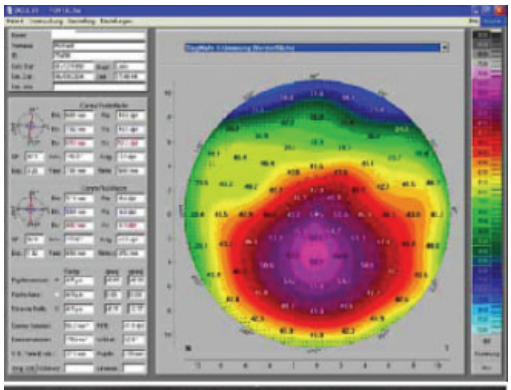
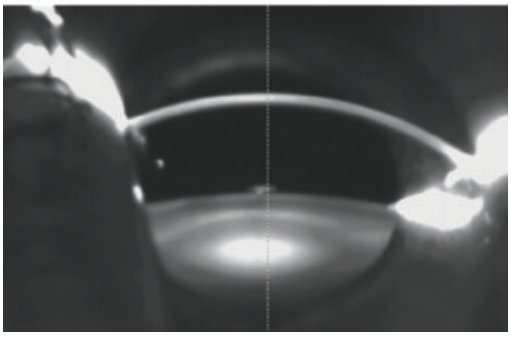
## Keratoconus and Cataract

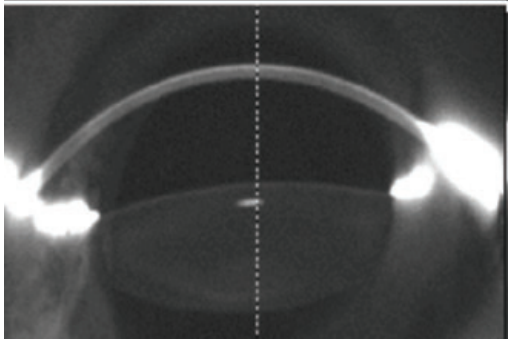
## Case report









*Right Eye* *Left Eye*

54 year old male asks for glasses. BSCVA is on both eyes 20/80. The Pentacam gives in 2 seconds the solution why: Right eye cataract with up to now undetected keratoconus, left eye no cataract but up to now undetected keratoconus.

With this information provided by the Pentacam we recommended the following surgical steps:
1. Cataract surgery on the right eye;
2. Deep anterior lamellar keratoplasty on the left eye;
3. Toric IOL implantation on the left eye after suture removal.

But there is still one question open for the right eye! Which K reading shall we use for the IOL calculation?

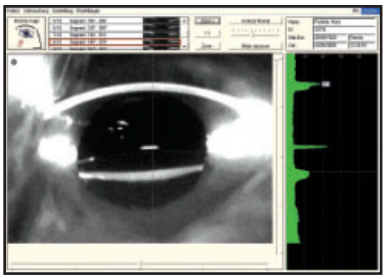
The Pentacam gives us the true and real measured central power of the cornea.

We used 42.9 for both K1 and K2. Postoperative refraction is +0.5 D of the intended refraction!

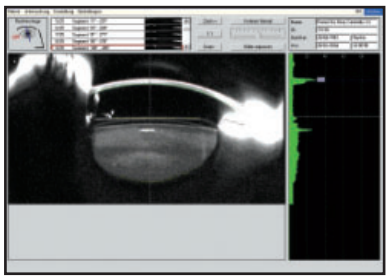
**NOTE:** The Pentacam measures the true corneal power while topographers have to extrapolate the central power of the cornea because of the blind spot in its center where the camera is located!

***The Scheimpflug images*** are created at the same time of the measurement.

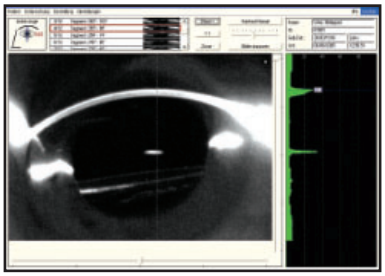
The densitometry of the lens is automatically quantified. The Scheimpflug images taken during the examination are digitalized in the main unit and all image data are transferred to the PC. When the examination is finished, the PC calculates a 3D virtual model of the anterior eye.



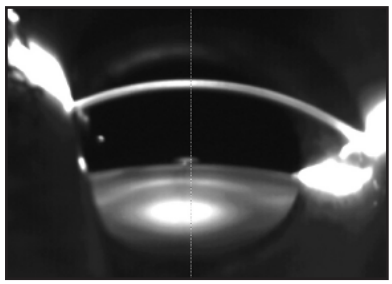
*Retained viscoelastic substance, or "captured visco," 6 years after IOL implantation.*



*Myopic Staar Visian ICL V4*



*Scheimpflug image of secondary cataract/Elschnig pearls.*



*Scheimpflug image of nuclear cataract*

## Summary

The most sensitive measure available to assess change, whether it is after refractive corneal or lens surgery or whether a patient is developing keratoconus, is a change in refraction. An instrument that provides a 3-D view, several different color maps of the corneal surface and additionally important clinical views of the anterior segment including the cristalline and intraocular lens changes can correlate refractive change to certain patterns. That may and will allow ophthalmologists to define when it is necessary to do something. Therefore we must use the best instrumenation available with high precision and reproducability. Let me close this article about the benefits of the Pentacam with a statement of M. Belin from Albany, New York: Using better instrumentation is not about eliminating patients or getting more patients. It is about picking the right patient.■