Wave Analyzer Questions

Alcon LADARWave System
Question #1

• How many locations over a 6.5 mm pupil are sampled?

• If using a lenslet array, how are they arrayed?

• What is the spacing?

• Can your technique define the path of a skew ray?
Question #1

The Alcon LADARwave™ aberrometer:

• Samples approximately 175 locations over a 6.5 mm pupil
  – Depending on the exact orientation of the pupil with respect to the lenslet grid

• Uses a lenslet array
  – Organized in a square rectilinear array with proprietary spacing
    • Magnification factor of the relay lenses that image the entrance pupil of the eye onto the lenslet array is proprietary.

• Does not define a unique path of a skew ray.
Question #2

• Exactly how does the LADARWave™ aberrometer reconstruct the wavefront error from the fundamental measurement?

• Can this reconstruction method measure the path of a skew ray without major assumptions?
The LADARWave™ uses a proprietary software process that:

- Identifies the focused wavelets at the CCD
- Associates each with the correct lenslet
- Calculates local wavefront slopes
- Then reconstructs the incident wavefront mathematically using Zernike coefficients.

This process does not require major assumptions concerning skew rays.
Question #3

• The more aberrated an eye the more noise there is likely to be in any given sampling location. How does the LADARWave™ aberrometer minimize the adverse effects of measurement noise when calculating and displaying wavefront error?
Question #3

The LADARWave™ aberrometer:

• First
  – Utilizes relatively fine sampling of the wavefront
    • The wavelet passing through any individual lenslet is relatively well-behaved.

• Second
  – The wavefront sensor has a large dynamic range
    • The individual wavelets are not excessively displaced at the CCD.

• Third
  – The software employs proprietary algorithms to filter out corrupted focal spots, and to "centroid" valid spots with high fidelity.

• Fourth
  – The reconstruction mathematics dictate that the wavefront is over sampled
    • There are significantly more wavefront slope measurements than Zernike terms which suppresses or averages out the noise arising from any individual compromised spots.
Wavefront Composite

5 measurements taken during exam

These 3 used for surgery
Question #4

• Name the top two reasons the Alcon laser refractive surgery system is superior to your competitors and provide what you believe to be the conclusive data supporting these two contentions.
Question #4

• The LADARWave™ aberrometer has:
  – A large dynamic measurement range
  – Been demonstrated at numerous public forum comparing different aberrometers.
  – Sophisticated registration technology
    • Allows very accurate placement of the treatment pattern by the LADARVision™ 4000 Excimer Laser.

The accurate measurement and registration allow the LADARVision™ system to treat the total aberration profile effectively.

The best supporting evidence of this fact is that the FDA allowed Alcon to include claims in the CustomCornea approval labeling relating to the superior optical quality of our wavefront-guided treatment.
Superior Wavefront Reproducibility and Accuracy

Reproducibility of Capture (6 mm pupil)  Accuracy of Capture

<table>
<thead>
<tr>
<th>Device</th>
<th>Reproducibility (microns)</th>
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</thead>
<tbody>
<tr>
<td>B&amp;L (60)</td>
<td>0.15</td>
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<tr>
<td>Tracey (64)</td>
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<tr>
<td>Topcon (85)</td>
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<tr>
<td>Alcon (170)</td>
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<tr>
<td>WFS (1017)</td>
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<tr>
<td>Nidek (1440)</td>
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Difference in Wavefront-Derived vs Cycloplegic Refraction
Question #5

• To achieve the benefits of wavefront guided corrections, the wavefront needs to be measured accurately and the laser needs to properly re-aligned the correction during the corneal ablation.

• In the Alcon platform, what does your system do, and what, ideally, could your system be doing to insure these steps are being performed as accurately as possible?
Question #5

- Answers to question #4 address part of this.

- Both the LADARWave™ aberrometer and the LADARVision™ 4000 excimer laser use video imagery and on-screen software reticles to:
  - Record the wavefront profile with respect to the anatomy of the eye (Wavefront Centration & Registration)
  - To reposition the necessary treatment pattern in exactly the same way. (Laser Registration)
Pupil Center Offset from Limbus

1. Locate Limbus
2. Locate Pupil
3. Measure Offset
Centration and Registration

Tracker Centration

Tracker Alignment
Center Shifts with Dilations
LADARWave® Future Software Features

- Auto-centration
- Automatic limbal ring placement

- Enhanced auto-fogging
  - faster response to neutralize accommodation
Thank You