# Agenda

1. Role of Optical Technologies in Ophthalmology
2. Demands of the Market - Trends in the Application
3. Implications for Photonics Technologies
4. Summary
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## Diagnostics and Biometry

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<th>Application area (diseases examples)</th>
<th>Technology</th>
<th>Devices</th>
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<td><strong>Structural Diagnosis</strong></td>
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<td>Retina (wet AMD, GA, Glaucoma, DR)</td>
<td>Imaging</td>
<td>OCT, Funduscamera, cSLO, Slitlamp</td>
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<tr>
<td>Anterior Chamber (Glaucoma)</td>
<td>Imaging</td>
<td>OCT, Slitlamp</td>
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<td>Cornea (Ceratoconus)</td>
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<td>Slitlamp, CLSM, OCT</td>
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<td>Peripheral Vision (Glaucoma)</td>
<td>Perimetry</td>
<td>HFA</td>
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<td>IOL selection (Cataract)</td>
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<td>OCT, ultrasound</td>
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<td>Placido disk</td>
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<td>Refractive correction</td>
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<td>Wavefront</td>
<td>Hartmann-Shack sensor</td>
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<tr>
<td>IO pressure (Glaucoma)</td>
<td>Tonometry</td>
<td>Tonometer</td>
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Big eye diseases: age-related macula degeneration (AMD), geographic atrophy (GA), glaucoma, diabetic retinopathy (DR)
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<tr>
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<th>Devices / Agents</th>
<th>Control / Management</th>
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<td>Laser therapy Retina (DR)</td>
<td>Coagulation</td>
<td>RGB cw lasers</td>
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<td>Retina (wet AMD)</td>
<td>PDT</td>
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<td>Fs lasers</td>
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<td>Pharmaceutical Anti-VEGF (wet AMD)</td>
<td>Intravitreal Injection</td>
<td>Lucentis, Avastin</td>
<td>OCT</td>
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<td>Surgical Procedures IOL replacement (Cataract)</td>
<td>Cuts, phaco-emulsification,</td>
<td>Tools, Ultra-sound, fs lasers</td>
<td>Surgical micros., OCT</td>
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<td>Membrane peeling, Viscocanaloplasty …</td>
<td>Mechanical</td>
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<td>Surgical micros., OCT</td>
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The Key Demand in Medicine Is Better Patient Care at Lower Costs

Patient Care

• Higher reliability
• Better outcome
• Lowering patient discomfort

Overall Costs

• Increased ease of use
• Reduced doctor time for routine tasks
• Fast amortization of investments
• Lower procedure costs (time, consumables, fees)
• Support in marketing, patient education and reimbursement

Trends

• More and better information
• Assisted analysis and diagnosis
• Increased efficiency by workflow optimization
Some Trends: Optimized Workflow
Current Examples

- patient management, connectivity, progression analysis → patient data management systems
- Operation of diagnostic tools by less-trained personnel
- Customized procedures, e.g. therapy
- Direct link between diagnosis and therapy, established in clinical trials (control, management, documentation) → Anti-VEGF therapy, controlled and managed by OCT

Example: treatment of wet AMD with Lucentis managed by OCT

Initial injections at months 0,1,2

3 more injections controlled by OCT (intraretinal fluid)

Some Trends: Diagnostic Information and Analysis
Current Examples

- More and better information
  - Multimodal devices $\rightarrow$ combination of OCT and fundus imaging
  - More biomarkers $\rightarrow$ fundus autofluorescence signatures
  - Quantitative results $\rightarrow$ retinal layer thicknesses
  - Higher sensitivity for earlier diagnosis (coupled with early therapy) $\rightarrow$ choroidal vasculature

- Assisted analysis/diagnosis
  - Normative data and statistical analysis
  - Registration and visualization of multimodal information
  - Follow-up analysis
Retinal Nerve Fiber Layer and Optical Nerve Head imaging with OCT and LSO for quantitative analysis and comparison with normative data.

Glaucoma

Cirrus™ 5.0
Carl Zeiss Meditec Inc.
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Implications: Some General Thoughts

- Some but not all trends can be addressed via photonics technologies (e.g. software plays an increasing role but strongly interlinked with photonic technologies)
- Often new technologies in the field require extensive clinical validation even if the potential relevance seems without doubt (example: high-resolution structural imaging via adaptive optics)
- To establish new technologies in medicine usually takes a long time of dedicated effort: from basic research to clinical prototypes to approved medical devices that need time to establish themselves (example: OCT)
OCT in Ophthalmology: Even Obvious Success Stories Need a Long Breath

1980ies Basic research
1991 patent application
1995 early prototype
1996 OCT1 (lab tool)
1997 OCT1 (modified)
2000 OCT2 (modified)
2002 Stratus OCT
2007 Cirrus HD-OCT

7+ other companies launch OCT systems

Adapted from: M. Kaschke et al.: „Optical Coherence Tomography“, Optik & Photonic 4 (2009), 24
New Successful Technologies in Medtech Industry Follow a “5-year development rule”

Example: OCT in Ophthalmology

- 1st generation: Lab tool
- 2nd generation: Workhorse
- 3rd generation: Advanced

Introduction of Lucentis for the treatment of wet AMD

Implications: Some Needs

- **Automated or semi-automated imaging** (auto alignment, intelligent system control)
- Quantitative imaging (calibration, reference standards, stability)
- **New modalities** (higher specificity, linking functional and structural information) and their combination with established modalities (hard- and software)
- **Sensitivity** improved imaging (detectors, resolution, depth penetration, simplified systems with less losses, coatings)
- Lower cost **components** typically with better functionality (high-power LED in the VIS and NIR, fs lasers, SLDs, swept sources, detectors, scanners, spectrometers, fiber components in the VIS, adaptive elements, filters, optics, coatings)
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Key demand in medicine is better patient care at lower (overall) costs

In ophthalmology photonic technologies often define the gold standard of care and will become even more prominent in the future

Trends in medical technology are:

- More and better information for therapeutic decisions
- Assisted analysis and diagnosis
- Increased efficiency by workflow optimization

New technologies require clinical validation and they most often can be established in a long process only → need to include clinical studies in funded activities

Relevant contributions of photonic technologies are towards, e.g.:

- Improved systems (automated/semi-automated, quantitative, sensitivity, versatility)
- New or improved modalities (for better care)
- Compact, reliable components at lower costs ideally with improved functionality