



# ABERROMETRY AND MF IOLS: WHAT WE CAN LEARN

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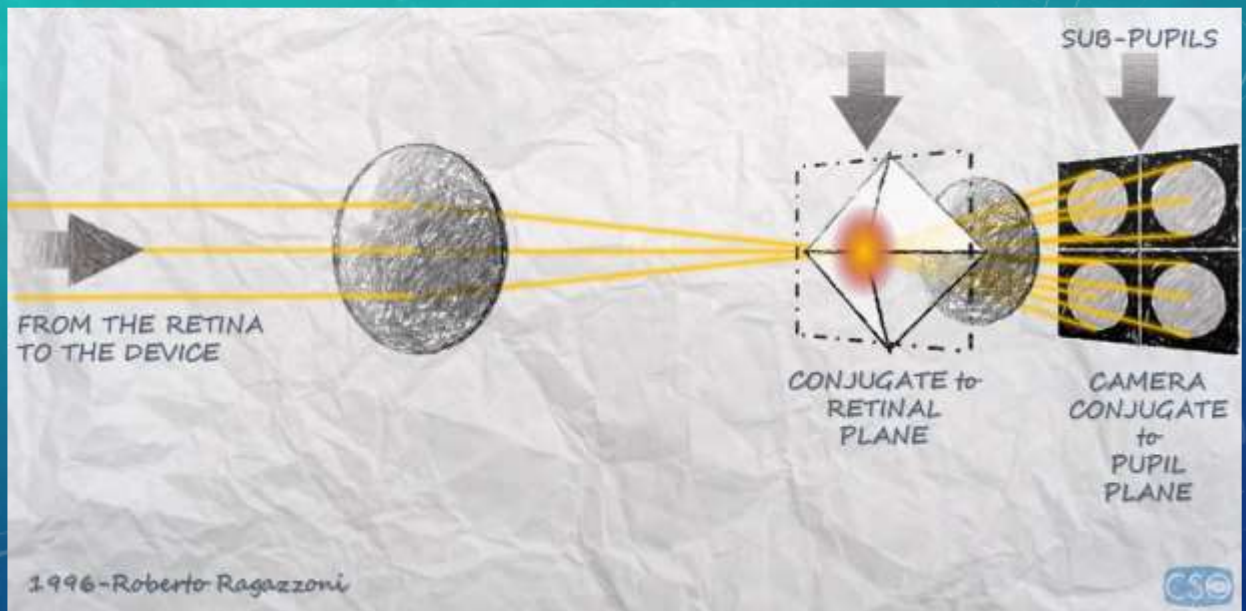
## FINANCIAL DISCLOSURES

Francesco Carones, MD consults for the following companies:

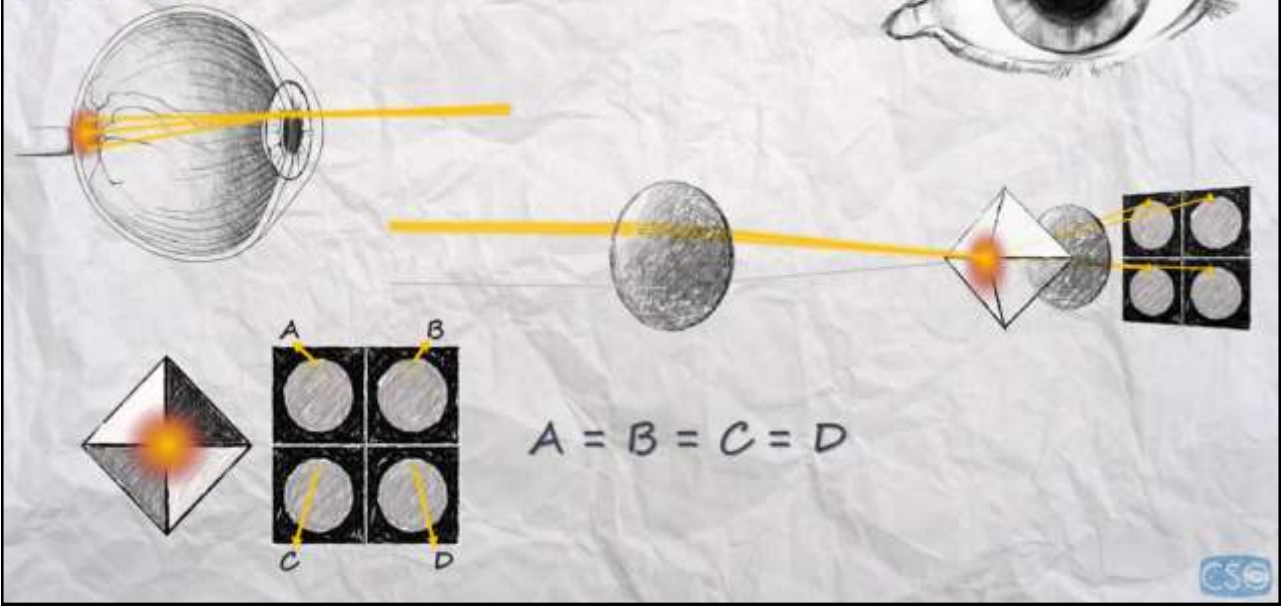
- **Alcon Laboratories (relevant to this presentation)**
- **CSO (relevant to this presentation)**
- **Johnson & Johnson Vision (relevant to this presentation)**
- Slack (not relevant to this presentation)
- Vivior (not relevant to this presentation)
- WaveLight (not relevant to this presentation)

## WAVEFRONT SENSING TECHNOLOGY

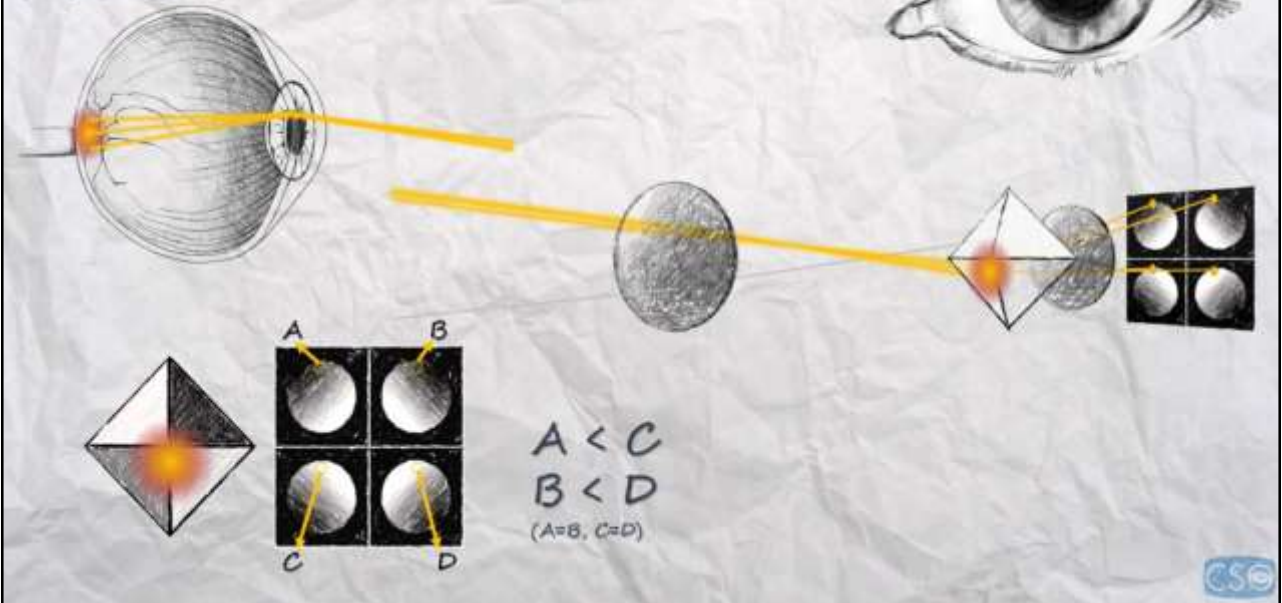
- Hartmann-Shack (Autonomous, AMO-VISX)
- Tscherning (WaveLight)
- Slit-lamp scanning skiascopy (Nidek)
- Ray Tracing (Tracey)
- Pyramid Wavefront Sensor (CSO, Schwind)



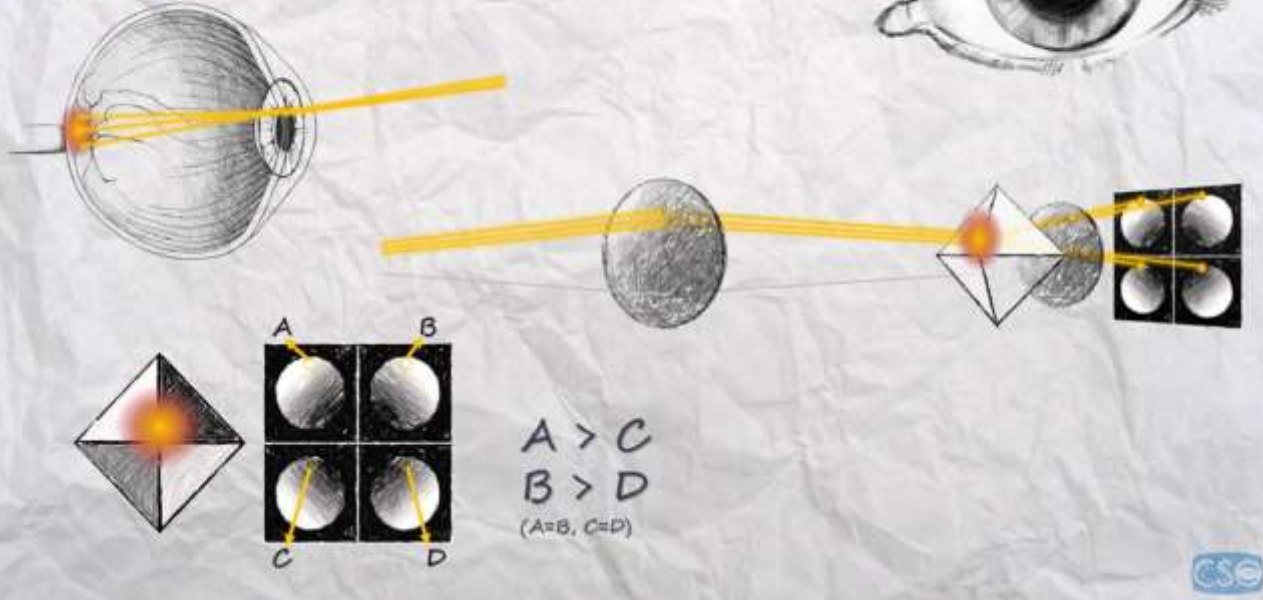
**EMMETROPIC RAY (SLOPE = 0):**  
Y-AXIS



**CONVERGENT RAY (SLOPE < 0):**  
Y-AXIS

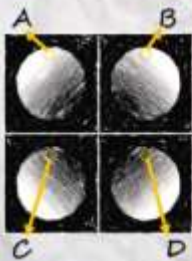


**DIVERGENT RAY (SLOPE > 0):**  
Y-AXIS



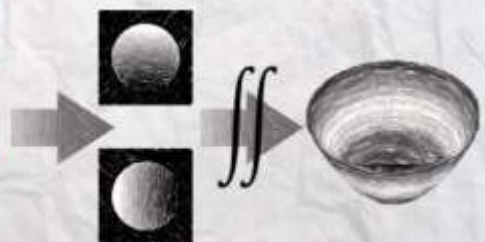
**WAVE-FRONT ERROR**

Relationship Slope and Light Intensity



$$\frac{\partial WF}{\partial y} \propto \frac{A+B-C-D}{A+B+C+D}$$

$$\frac{\partial WF}{\partial x} \propto \frac{A+C-B-D}{A+B+C+D}$$





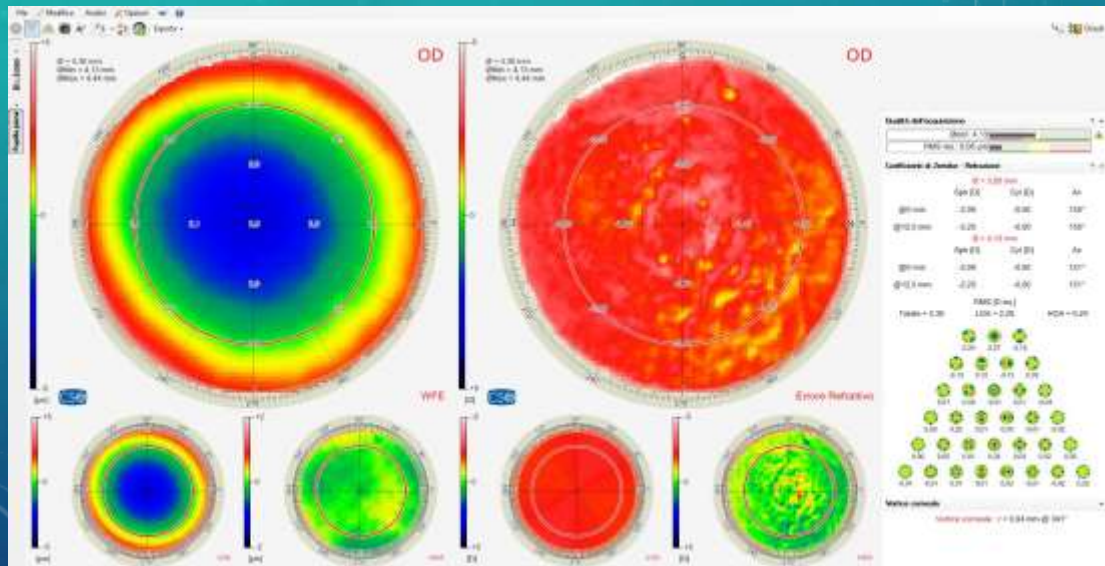
## CSO *OSIRIS* ABERROMETER

### Pyramidal Wavefront Sensor (PWS)

- Spatial resolution:
  - 45.000 data point ( $\varnothing= 9.0$  mm)  
(1.500 other technologies)
  - 4.500 data point ( $\varnothing= 3.0$  mm)  
(150 other technologies)
- Sensitivity:
  - 4096 shades of gray



## EXAMPLE: MONOFOCAL IOL, -2.00D



### EXAMPLE: MONOFOCAL IOL, -2.00D



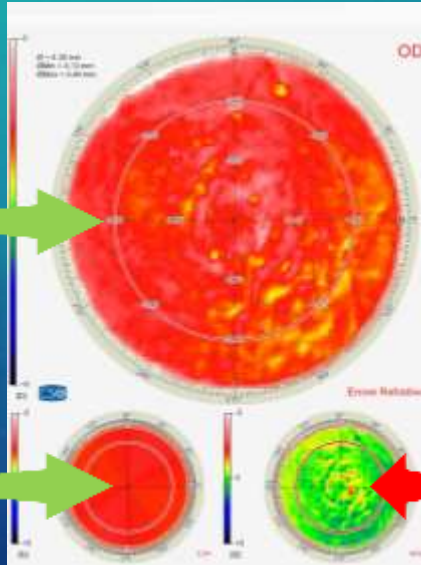
Total aberrations



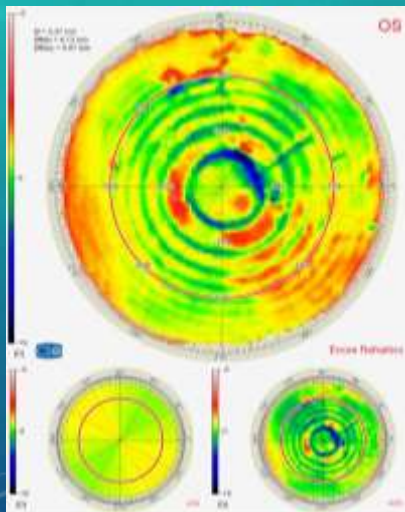
Low order aberrations



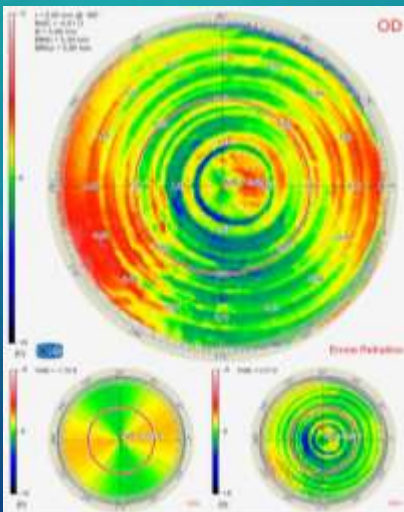
High order aberrations



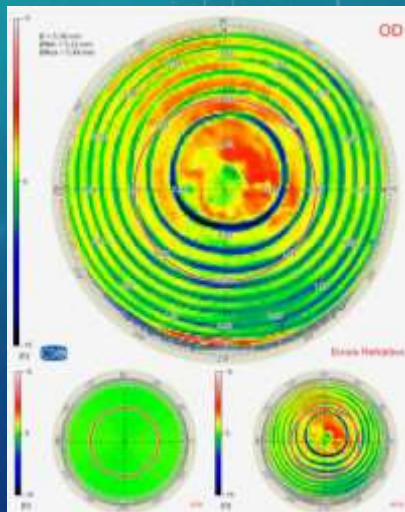
### EXAMPLES: PRESBYOPIA-CORRECTION DIFFRACTIVE IOLS



BIFOCAL (ReStor 3.0)



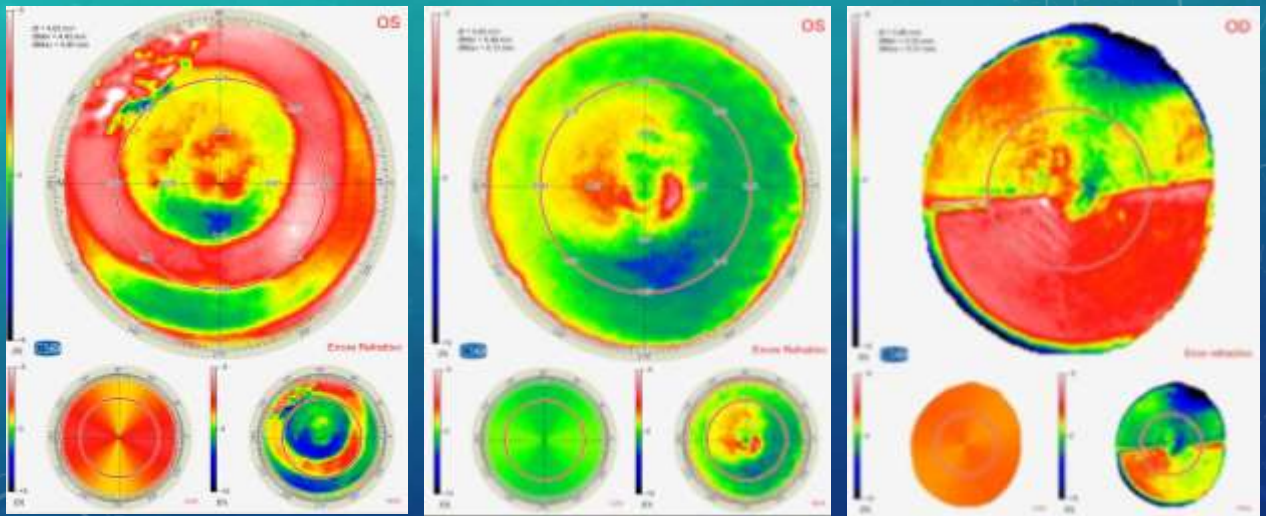
TRIFOCAL (PanOptix)



EDOF (Symfony)



## EXAMPLES: PRESBYOPIA-CORRECTION REFRACTIVE IOLS



Zonal Refractive (ReZoom)

Pos/Neg SA (MINIWELL)

Segmental Refractive (MPlus)



## CLINICAL EVALUATION IN EYES IMPLANTED WITH PRESBYOPIA-CORRECTING IOLS

120 implanted eyes, 1-12 months after surgery

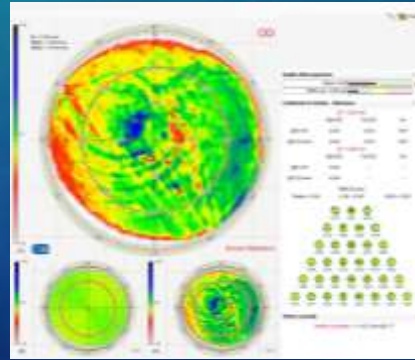
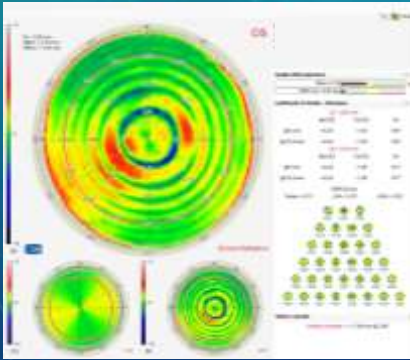
- 40 Alcon PanOptix (trifocal, diffractive)
- 40 J&J Vision Symphony (EDOF, diffractive echelette)
- 20 Alcon ReSTOR 3.0 (bifocal, diffractive)
- 10 Alcon ReSTOR 2.5 (bifocal, diffractive)
- 10 SIFI MiniWell (EDOF, positive/negative spherical aberration)



## MAIN OUTCOMES – CENTRATION

Measurement in relation to the visual axis or center of the pupil

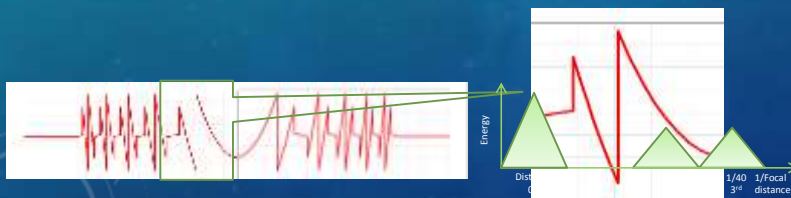
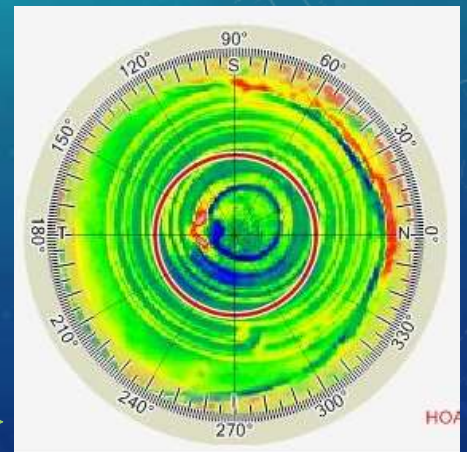
- Impact of decentration on PSF and Simulated Visual Acuity



## MAIN OUTCOMES – DIFFRACTIVE PATTERN

Optical design detection in 100% of IOLs

- Central area diameter and focus
- Number of diffractive steps
- Dioptic value of add power



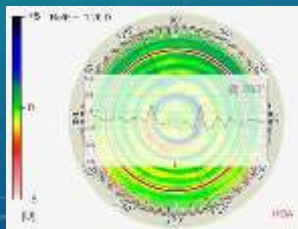




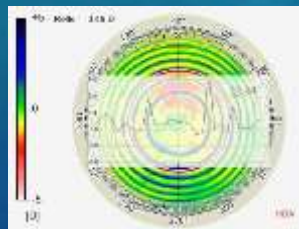
## MAIN OUTCOMES – ADD POWER

Measurement of the dioptric range and multifocality

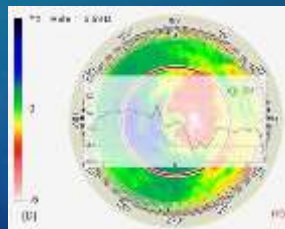
- Dioptric range
- Peak to valley



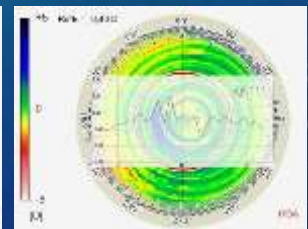
ReSTOR 3.0



Symfony



MiniWell



PanOptix



## AD INTERIM CONCLUSIONS

The Pyramid Wavefront Sensor (PWS) proved highly sensitive and with a much higher spatial resolution than the other wavefront sensors

- Much more detailed measurements
- Very useful information

The software needs to be developed as to make all measured information more user friendly for researchers and clinicians

