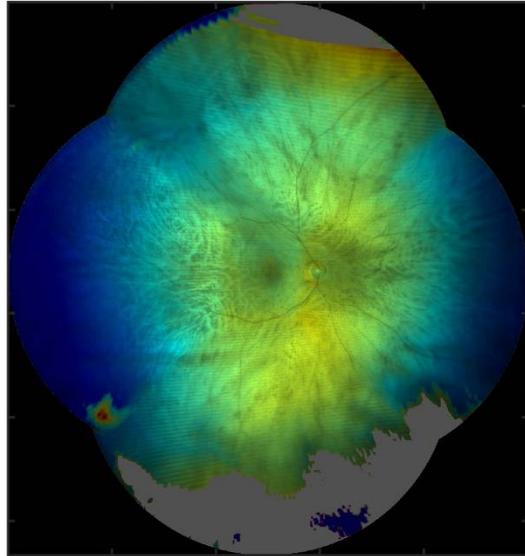


Slit-scanning ophthalmoscopy to measure ultra-widefield peripheral refraction along nasal/temporal and superior/inferior meridians



Katharina G. Foote, PhD; Conor Leahy, PhD; Matt Everett, PhD;
Jochen Straub, PhD



Disclosures

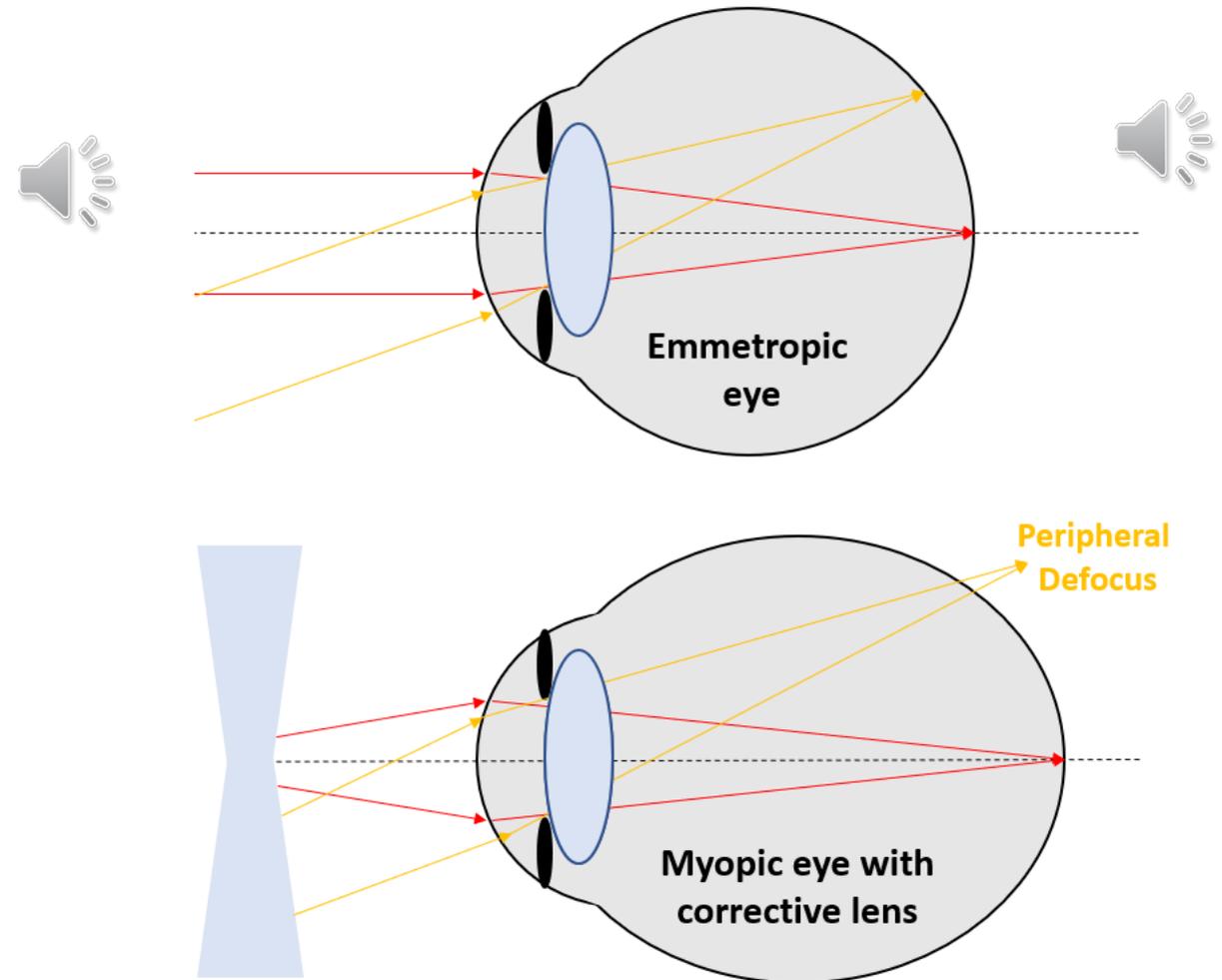
Carl Zeiss Meditec, Inc. (CZMI), Dublin, CA, USA

- Katharina G. Foote, PhD: CZMI (E)
- Conor Leahy, PhD: CZMI (E)
- Matt Everett, PhD: CZMI (E)
- Jochen Straub, PhD: CZMI (E)



Background

- Most researchers agree that myopia causation is multifactorial
- One of the many risk factors for myopia: **peripheral defocus**
- Myopic eyes are prolate (oblong) in shape
- Some studies show that relative peripheral hyperopia precedes myopia development, but there is conflicting evidence^{1,2}



¹Mutti DO et al., *IOVS*, 2011 Jan 1;52(1):199-205.

²Atchison DA et al., *IOVS*, 2015 Sep 1;56(10):6162-70.

Background

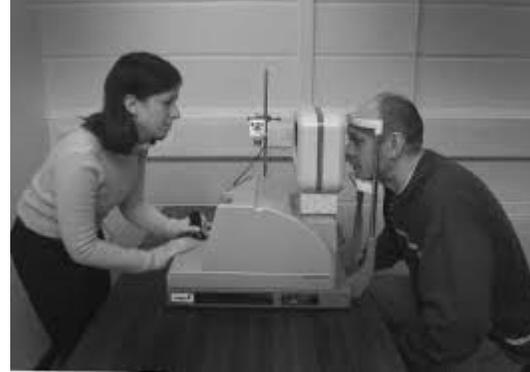
- **Central Refraction (standard):** Measure refractive error at one point only (the fovea)
- **Peripheral Refraction:** Measure refractive error at *many points in the periphery, one at a time*



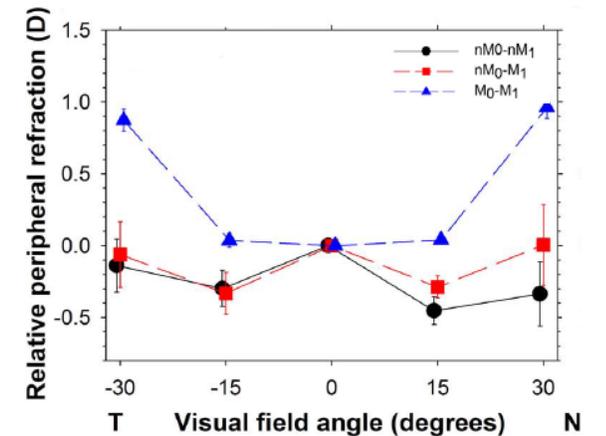
VISUREF®



Grand Seiko
WAM-5500®



McClelland and Saunders, *Ophthalmic and Physiological Optics*, 2003.



Atchison et al., *IOVS*, 2015.

Background

- Autorefractors typically measure over a limited range of visual field angles.
- Retinal imaging, particularly ultra-widefield (UWF) imaging, has demonstrated utility in visualizing the periphery. UWF slit-scanning ophthalmoscopes can measure peripheral refraction over a wider field of view (FOV) and are faster and easier to use than open-field autorefractors¹.



Grand Seiko WAM-5500®
Open-field autorefractor



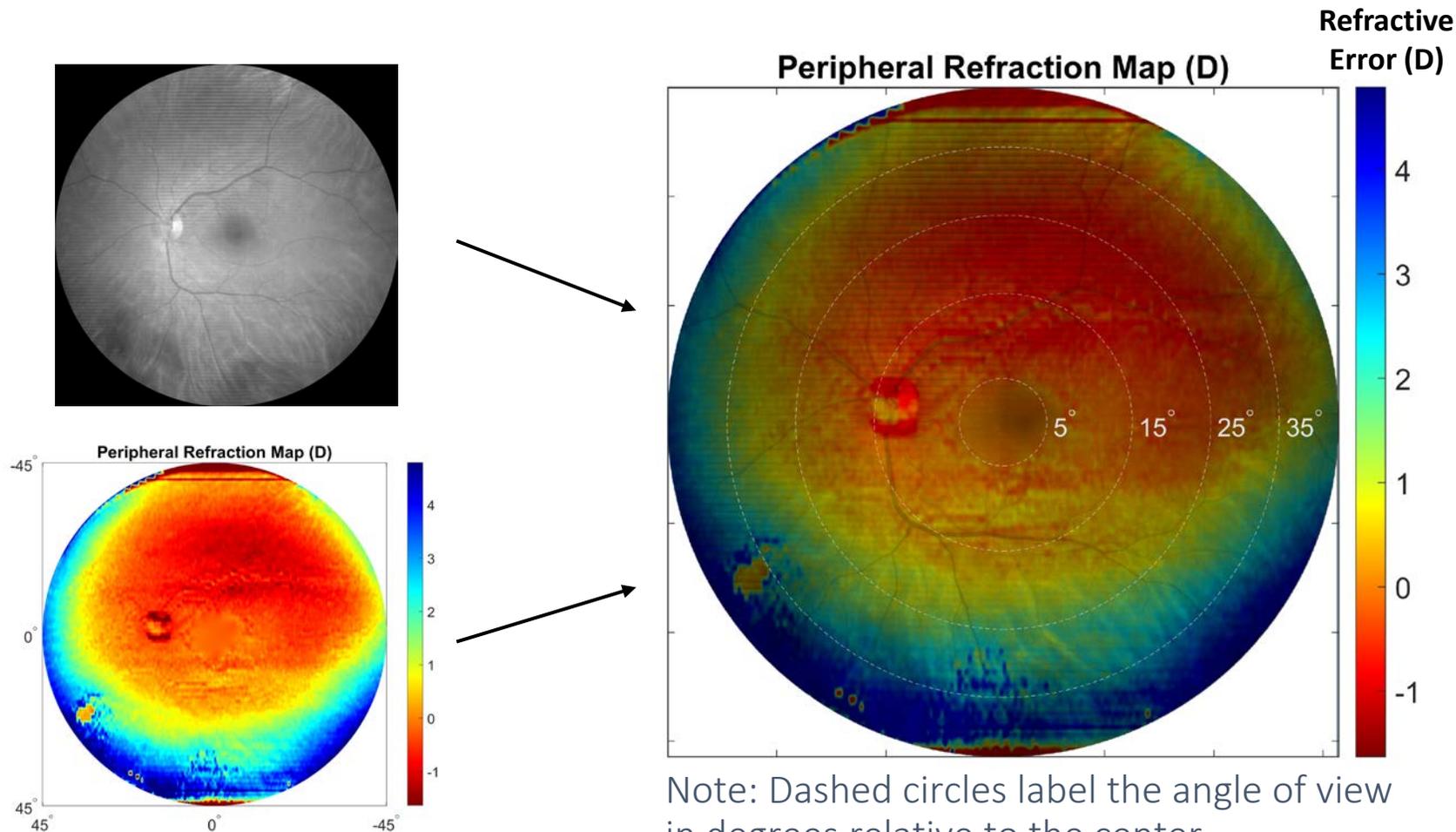
CLARUS™ 500
Slit-scanning ophthalmoscope



¹Foote et al., *IOVS*, 2020.

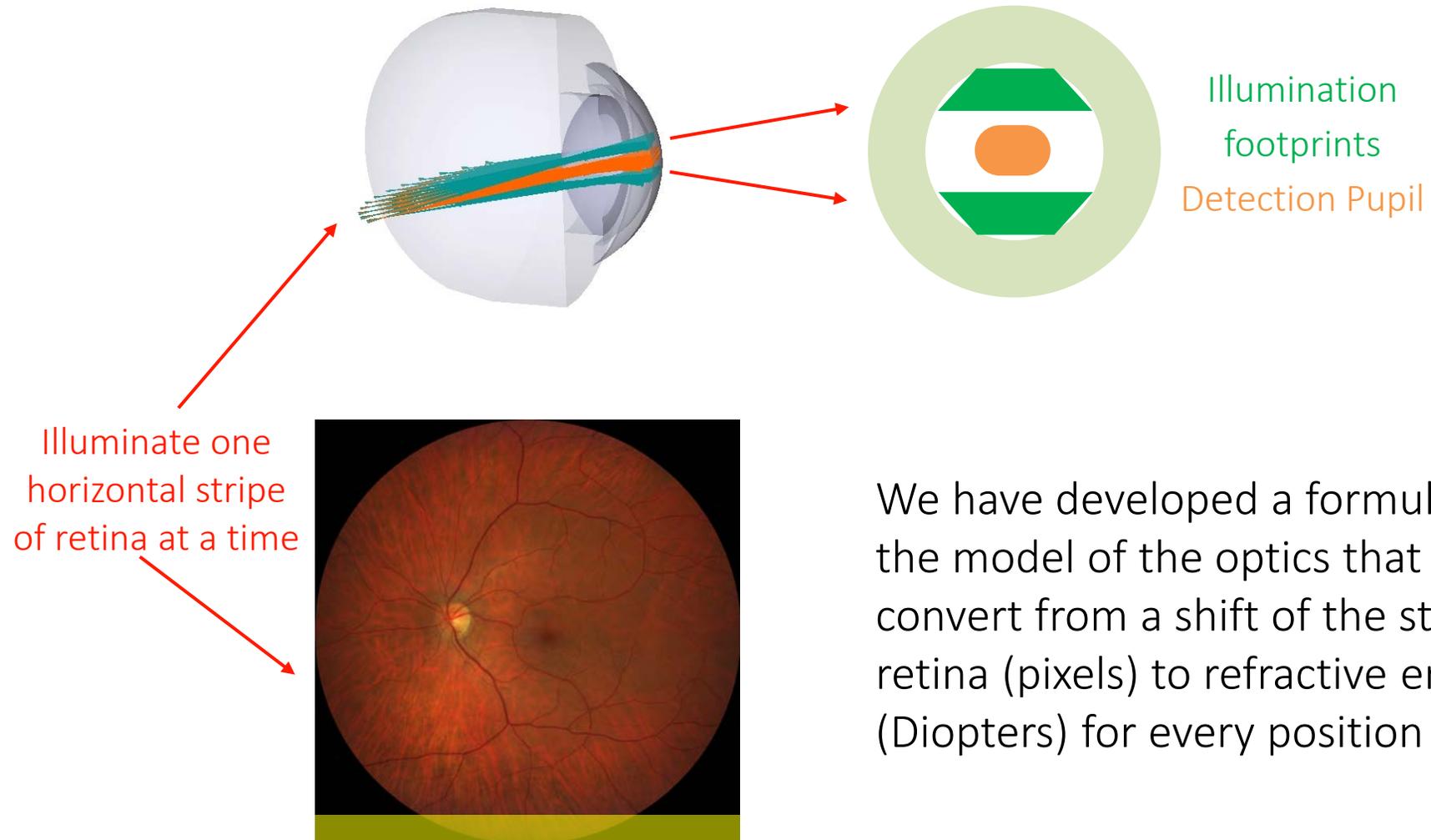
Background

Peripheral Refraction: Measure refractive error at *many points in periphery, single shot*¹



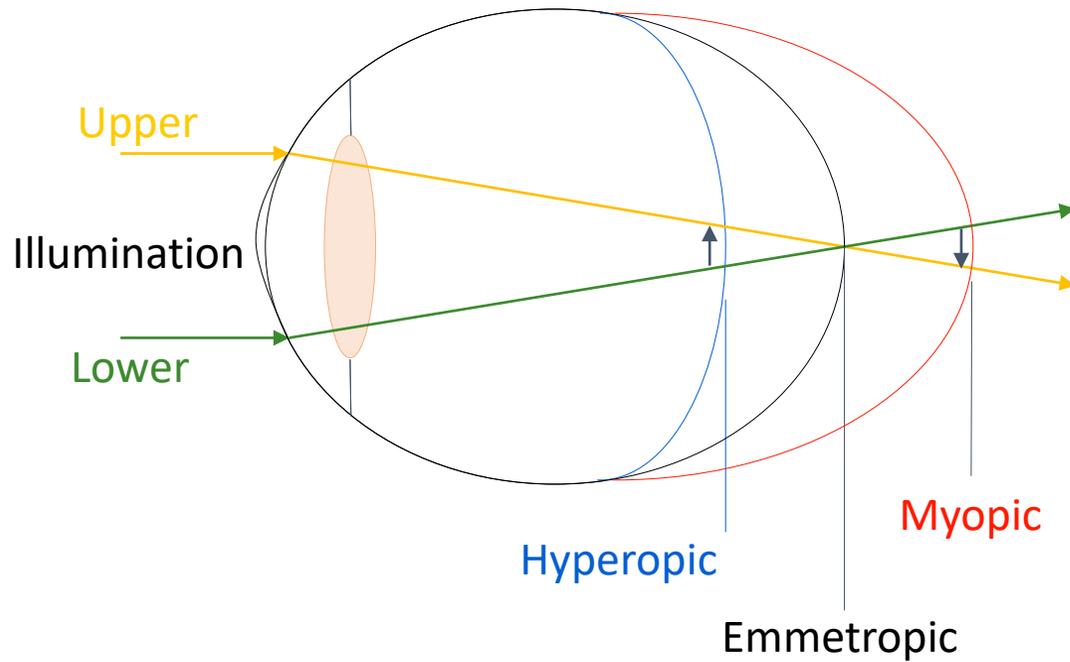
- Why this technique is useful:
- 1 acquisition (<200ms) yields:
 - Reflectance image
 - Peripheral refraction map
 - 90° FOV

Background

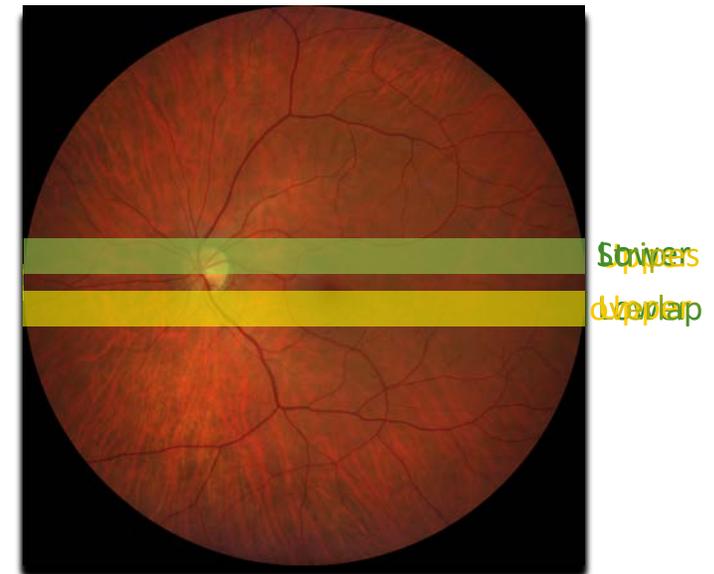


We have developed a formula based on the model of the optics that allows us to convert from a shift of the stripes on the retina (pixels) to refractive error (Diopters) for every position in the field.

Background



Emmetropic:
Myopic
Stripes Overlap



Purpose

- Purpose: A prospective study was performed to examine UWF imaging feasibility to extend peripheral refraction measurement range to a full 130°.



Methods

- Modified widefield slit-scanning ophthalmoscope (CLARUS™ 500, ZEISS, Dublin, CA) with prototype software
- 5 subjects: spherical equivalent ranging from -12.25D to 0.00D
- Images were acquired with the internal fixation at central position, and $\pm 20^\circ$ offsets along each meridian
- The vertical component of refraction over the full FOV was determined
- Fundus features were used to co-register and merge the fields, resulting in a 130° peripheral refraction map

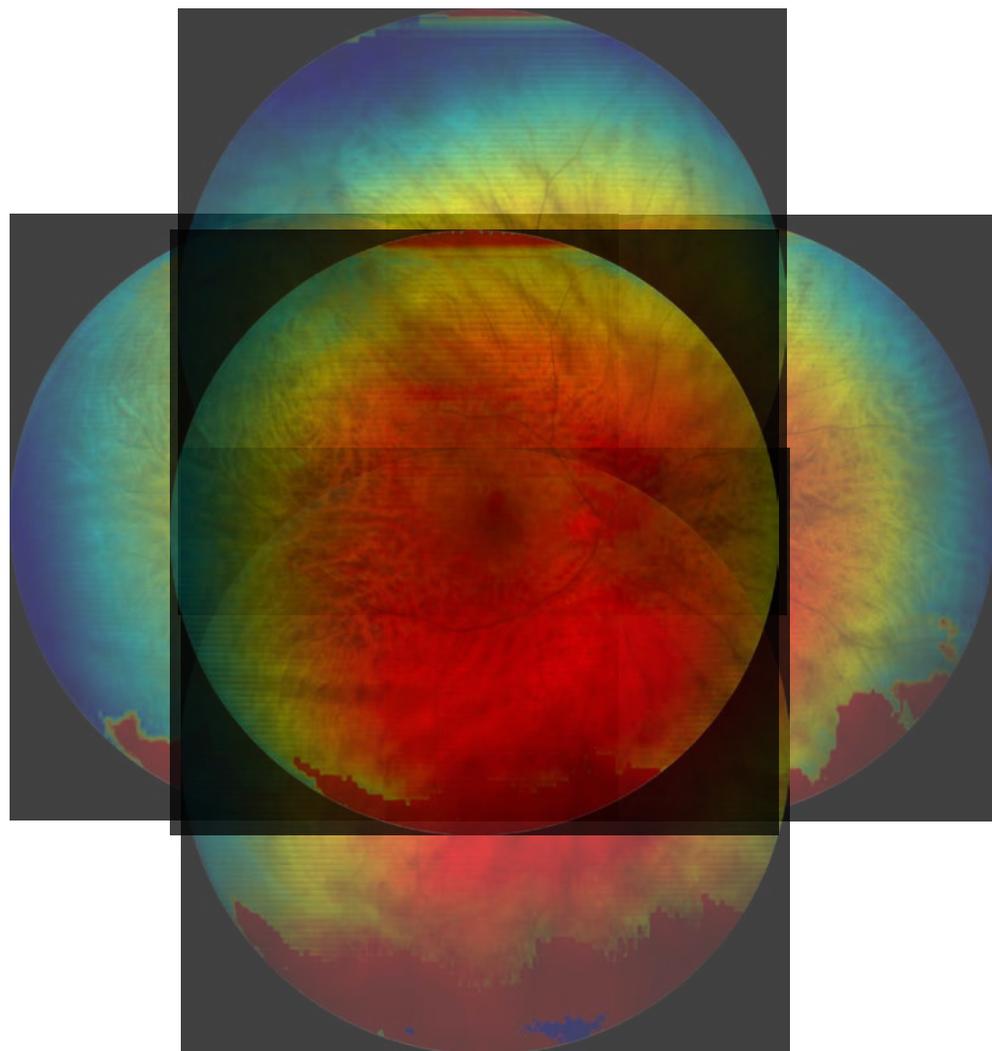


SID	Eye	SE (D)
053	OS	-12.25
243	OD	-8.00
298	OS	-0.25
873	OS	-0.50
912	OS	-1.50

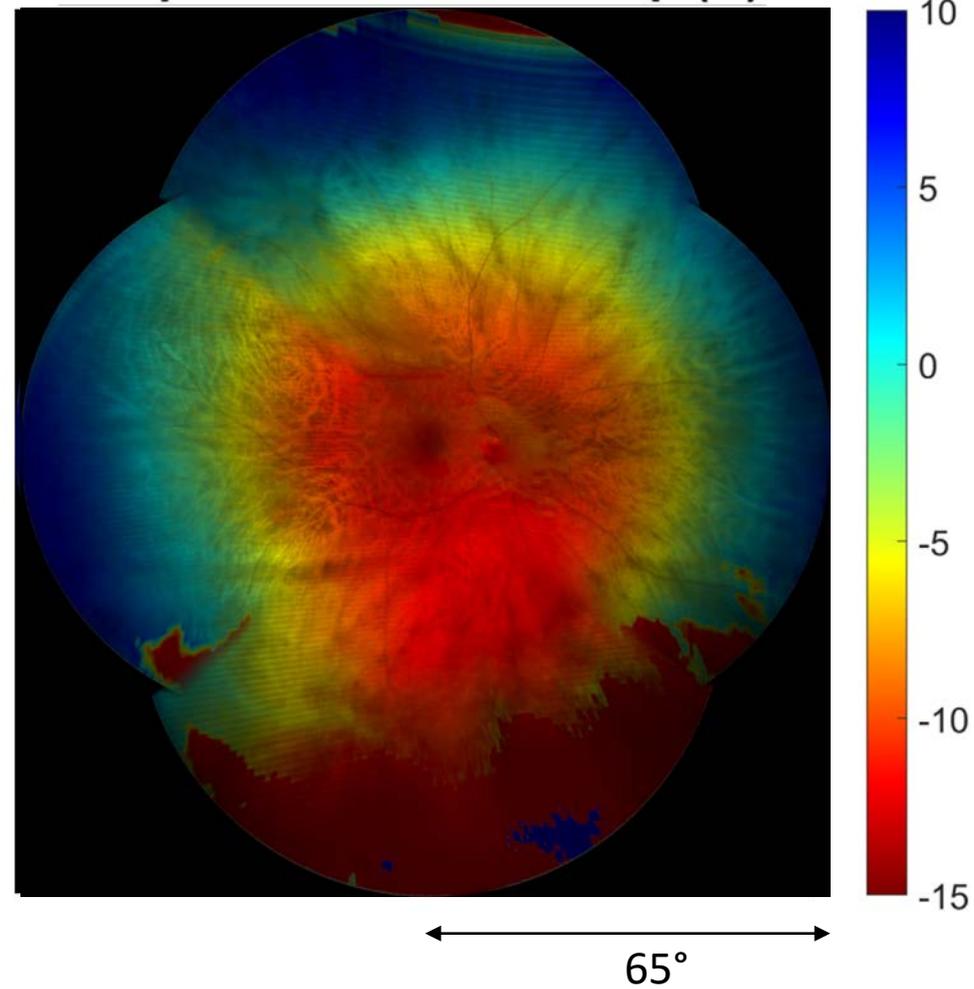
Methods



Methods

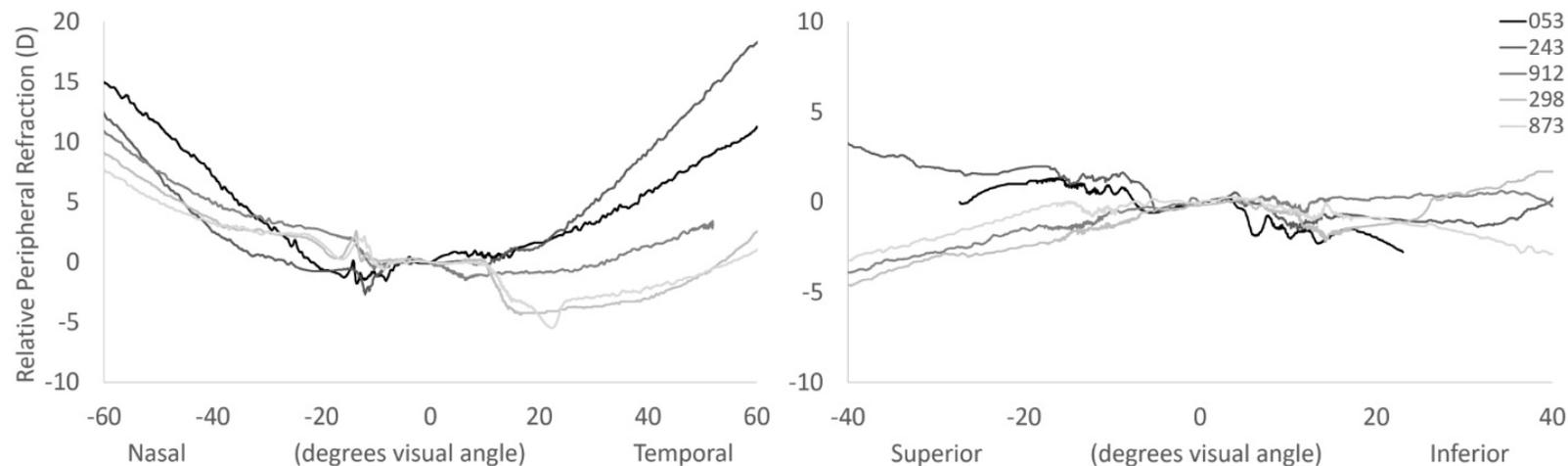


Peripheral Refraction Map (D)



Results

- Relative peripheral refraction along the full nasal/temporal and superior/inferior meridians is displayed.
- These measures were computed from an average of 1° strip for each subject.
- Most myopic subjects show characteristic relative peripheral hyperopia along the nasal/temporal meridian and relative myopia along the superior/inferior meridian.

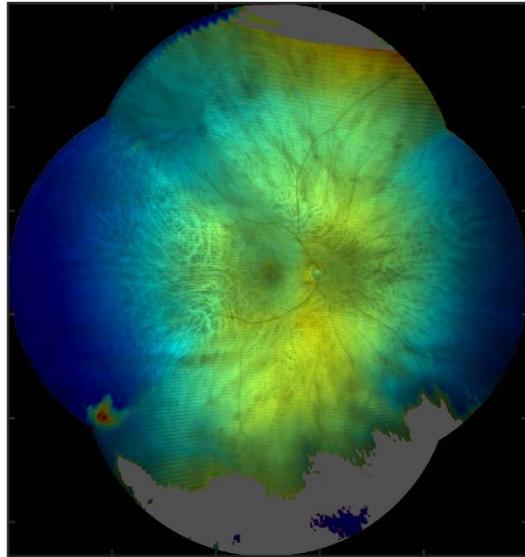


Conclusions

- This study demonstrated a capability of extending the map of peripheral refraction over an ultrawide FOV
- This measurement technique could be useful for enhancing research in the field of myopia



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