Opthalmology task force
Teleconference
15 May 2014 • 10:00 (EDT)

The meeting was called to order by Mr Craig Revie, chair of the ICC Medical Imaging Working Group, with the following attendees:

Katelyn Donovan
Michael Flynn
Phil Green
William Fischer
Craig Revie
Christye Sisson
William Li
Hong Wei
Tom Lianza
John Penczek

Following a sound check, Mr Revie reminded the attendees of forthcoming face-to-face meetings of ICC MIWG, including 19-20 June at the FDA in Washington (where there will be a panel session with FDA members and a discussion of how to move forward on 20 June) and a meeting in Boston on 1 November (followed by ICC DevCon on 3 November and CIC/IADP conferences later that week.

Mr Revie handed over the meeting to Ms Christye Sisson, leading the Color Eye Model activity in MIWG. She presented an update on the activity [see attached], beginning with an overview of previous work undertaken in Phase 1 of the project. Retinal imaging is a unique capture technology in which variability between cameras generates significant colour disparity, and the aim is to improve agreement between such cameras.

Ms Sisson described the imaging procedure used in these systems. After dilation of the pupil, tungsten illumination is used to align the components, and then flash is used for the capture. Systems which do not require dilation are not in the scope of this activity. Illumination is annular, and the light reflected axially and passing through the annulus of illumination is captured by the camera. The light has to pass through the cornea, lens and vitreous. Retinal colours cover a much smaller gamut than other forms of photography.

The main imaging variables were identified, and the significant variation they cause was shown. One goal was to quantify the differences which arise from these variables and consider the possibility of using an ICC profile to correct for camera-dependent variation.

The correction of the different images shown, while not perfect, gave a proof of concept that agreement could be improved. Some variation could arise from the vendor-specific methods used to render the images after capture, including sharpening and colour adjustment. Only one manufacturer allows access to camera raw RGB data, and the group is looking into the possibility of accessing raw data from other systems.

The correction procedure used is described in a paper published earlier, and Ms Sisson agreed to provide a copy that can be posted on the ICC web site.

Goals of Phase 2 included determination of the minimum patch size and the imaging protocol to use. The option for a standard viewing angle was used in the camera setup, as this was most common clinically, and exposures were bracketed. It appeared that the tungsten illumination influenced the final colour, possibly arising from variation in the duration of flash exposure. Illumination was noticeably uneven, and consistency between exposures was low. However, the large variation is representative of actual use.

In Phase 3, the goal is to modify the selection of colour patches and the eye construction, finalise the imaging protocol and test at multiple sites. It was undetermined whether the final system should be implemented at user level, or by manufacturers.

Dr Michael Flynn asked whether the FDA should consider regulating the output of retinal imaging systems. Ms Sisson responded that she would like to see manufacturers reach agreement on the set of colours which should be accurately imaged for a baseline profile, and then add vendor-specific rendering on top.

The meeting discussed ways in which the variation in illumination could be reduced or corrected. Ms Sisson explained that diffusion of the incident light was not an option owing to the need for the return light path to pass through the incident annulus. It was suggested that adding neutral patches around the test target would enable a spatial uniformity correction to be performed.

The magnification changes the barrel distortion of the captured image, clipping some patches at the corners, although correction for such geometric distortion should be straightforward.

Dr John Penczek noted the overlap with work of the Medical Photography group and suggested maintaining contact.

The target was based on a 24-patch Macbeth ColorChecker, using similar materials. Mr Thomas Lianza noted that the ColorChecker was not originally designed for calibration, and suggested working with the Munsell group at X-Rite to define target spectral reflectances based on analysis of retinal spectral measurements. Ms Sisson noted that the colour and contrast variation in human retinas was larger than shown in her slides, especially when different ethnic populations and retinal pathologies were included.

Ms Sisson and Mr Revie thanked the participants and closed the meeting.

A full recording of the meeting is available at http://www.npes.org/Portals/0/standards/2014-05-15%2009.57%20ICC%20MIWG_%20Ophthalmology.wmv

Action items from the meeting:

MIWG-14-05 Provide paper on Phase 1 results for publication on ICC web site (Sisson)
[http://www.color.org/groups/medical/ PhaseIOphColor_Witwer.pdf]

Progress Report: Color Consistency Analysis in Fundus Photography

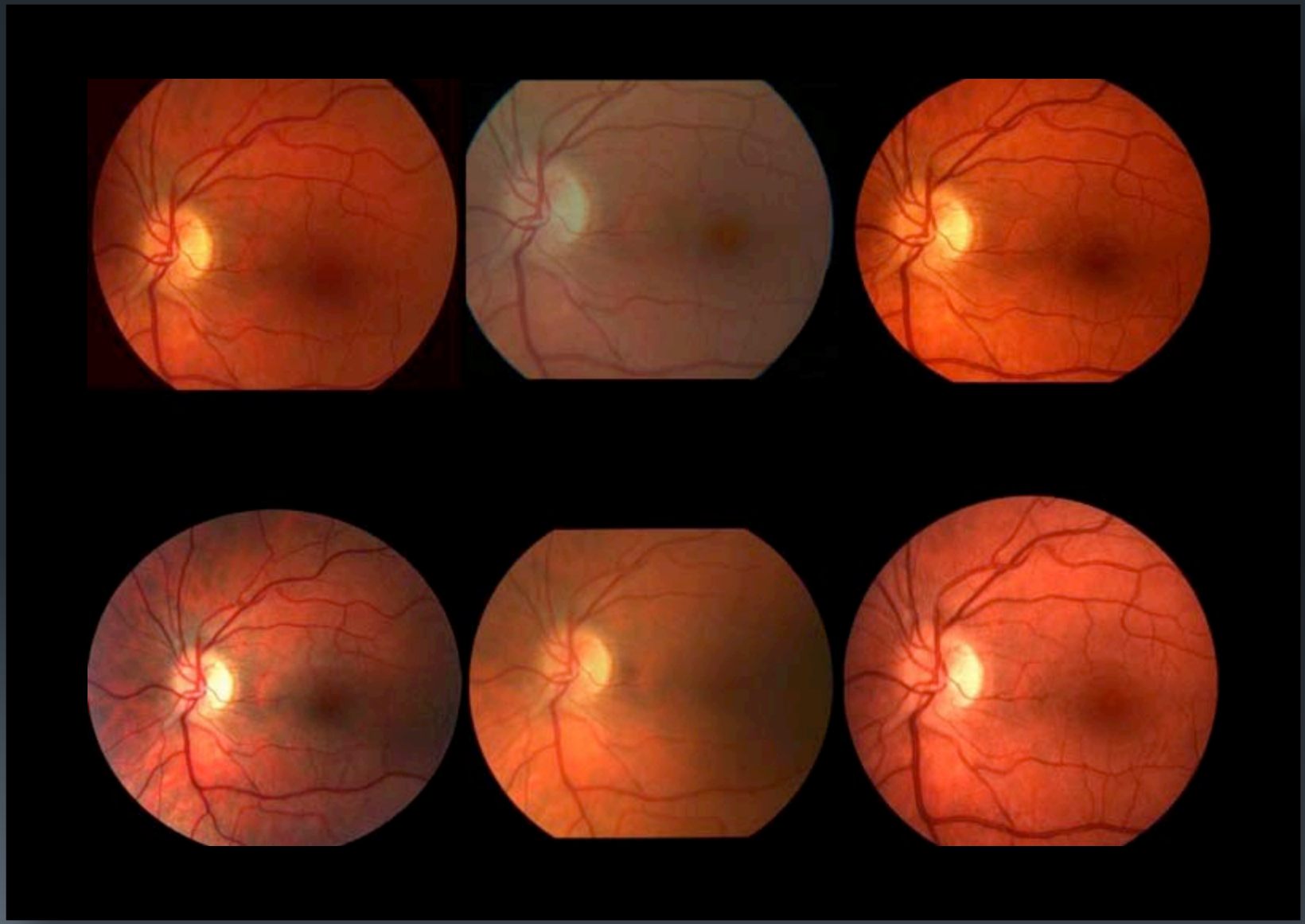
Christye P. Sisson, CRA, MS

Associate Professor

Ronald and Mabel Francis Endowed Chair, Program Chair: Photographic Sciences

School of Photographic Arts and Sciences

Image Variables



Imaging Procedure

- Iris dilated pharmaceutically
- Once dilated, patient aligned in fundus camera headrest
- Photographer adjusts working distance for optimal illumination, focus
- Photograph taken using flash

Image courtesy of National Eye Institute: http://www.stylewiz.com/mnr/nei/photo-gallery.php

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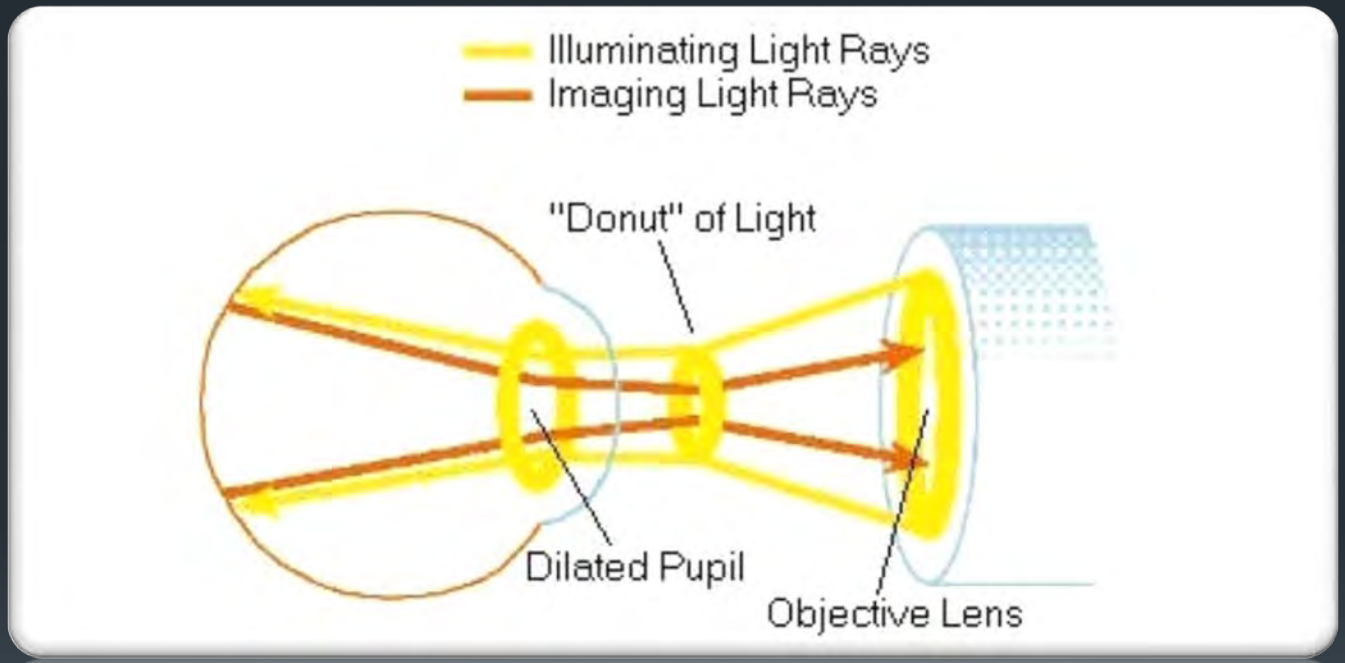
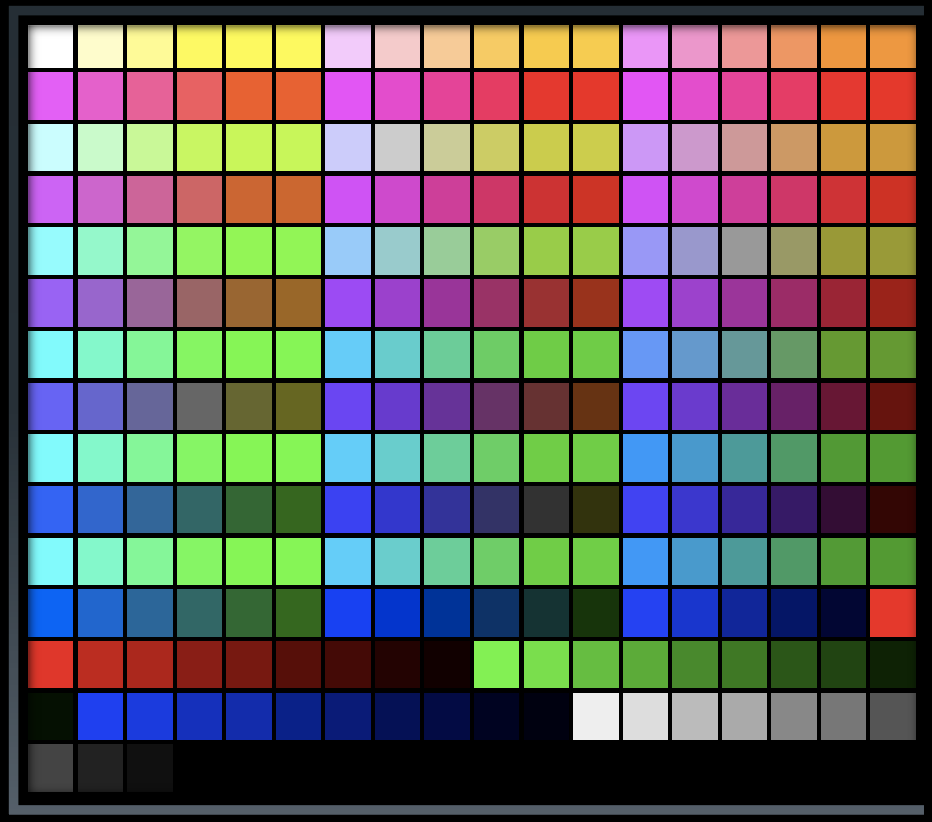
Eye as other half of optical system



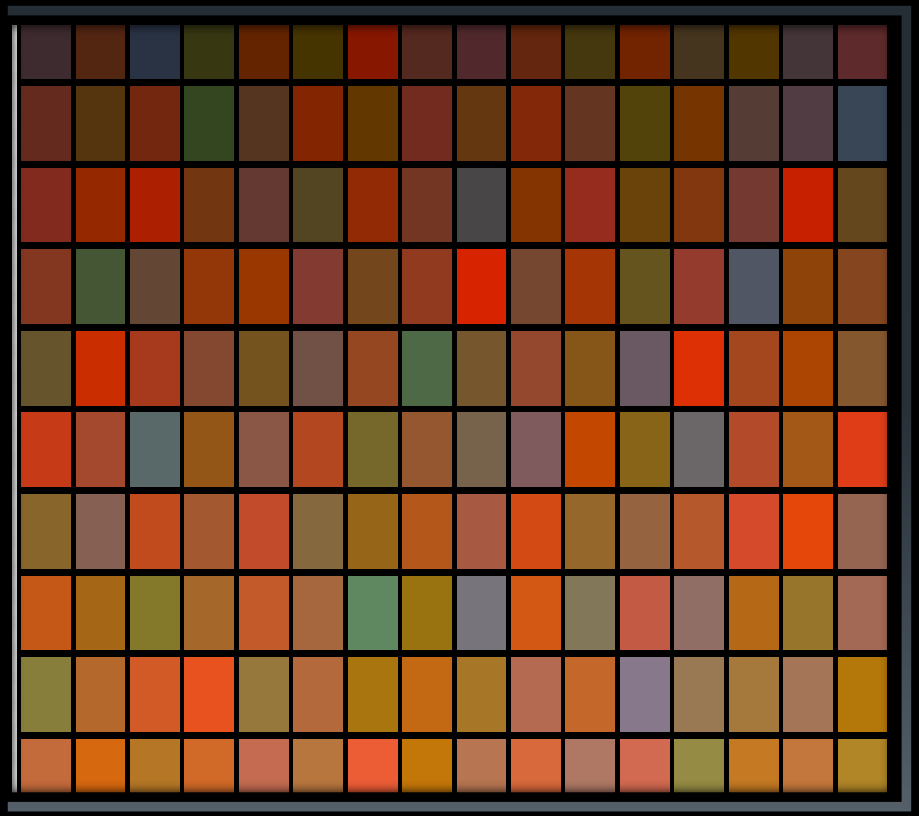
Ophthalmic Photography: Retinal Photography, Angiography, and Electronic Imaging, 2nd Edition Patrick J. Saine and Marshall

CCD Color Reproduction

Standard colors



Retinal colors

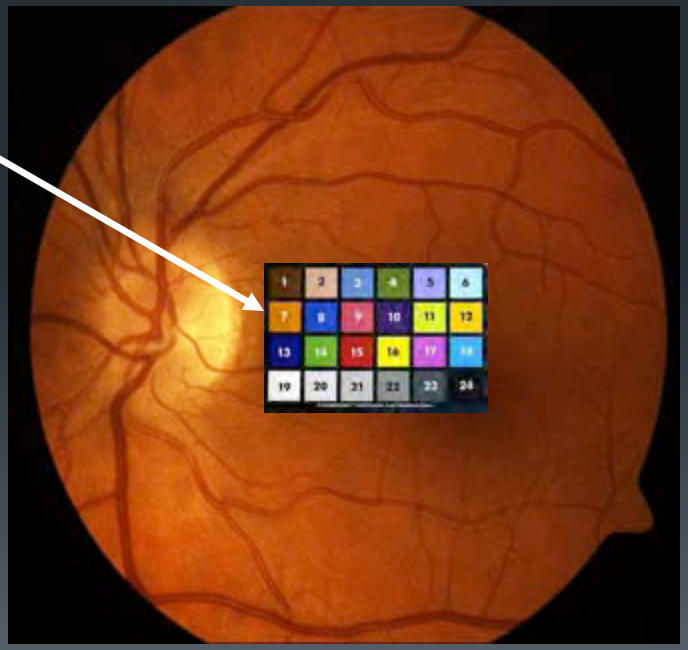


Questions

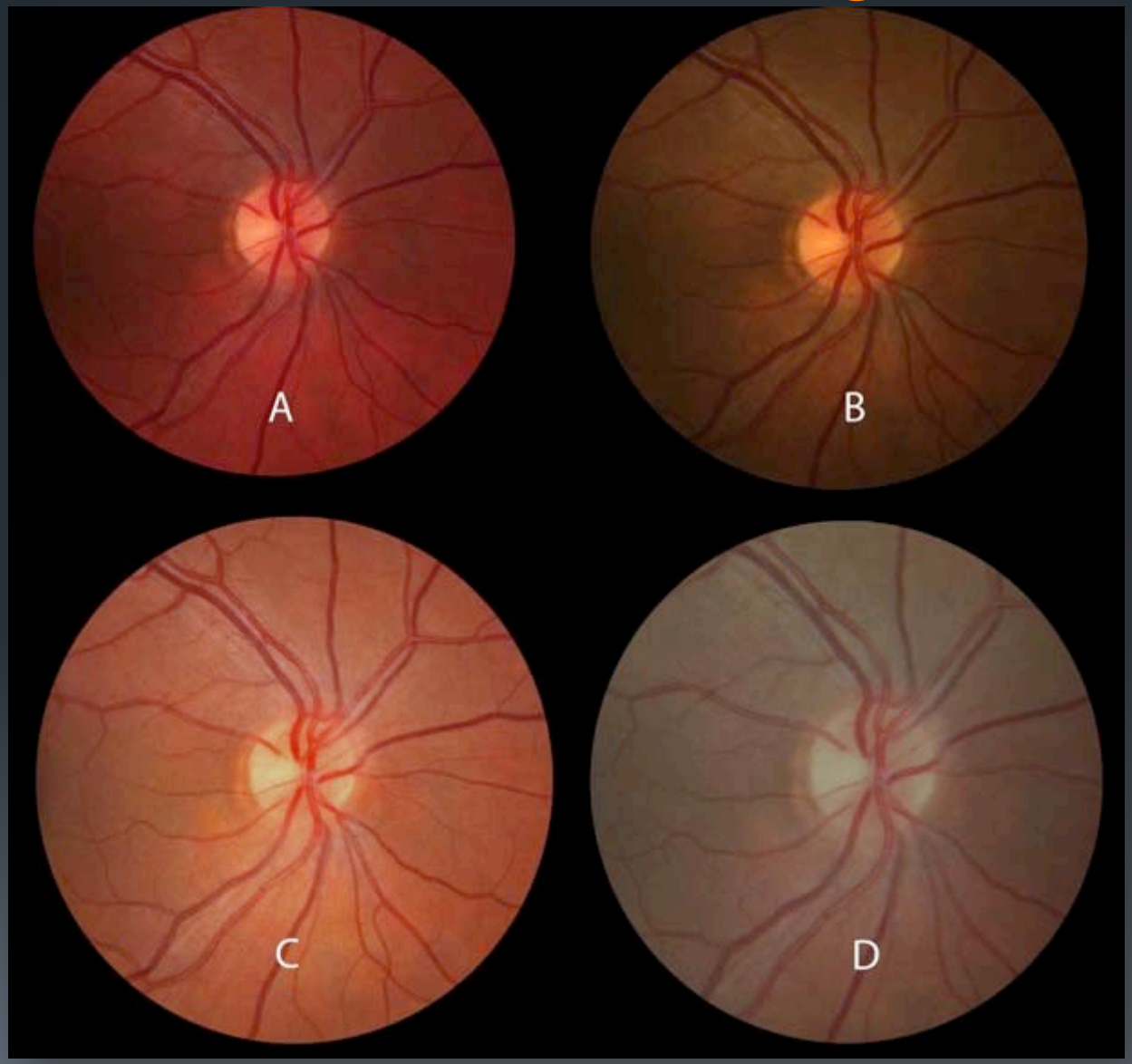
- How different are the cameras in terms of color?
  - What is the best way to determine color differences?
- Can fundus cameras be profiled to a common color standard?

Another Issue…

- How do I practically profile my input? (fundus camera)



Camera Testing: Phase I

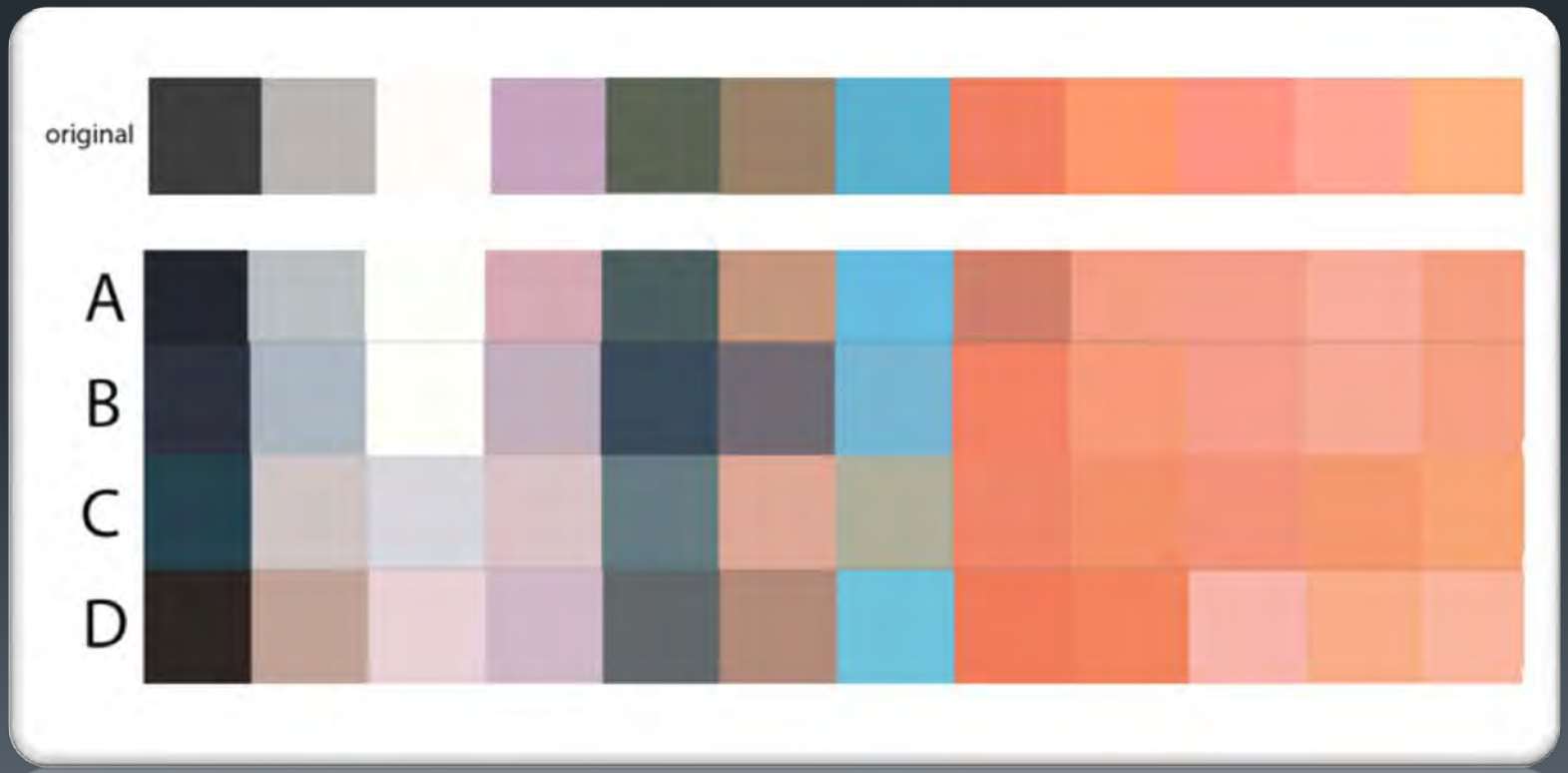


Procedure

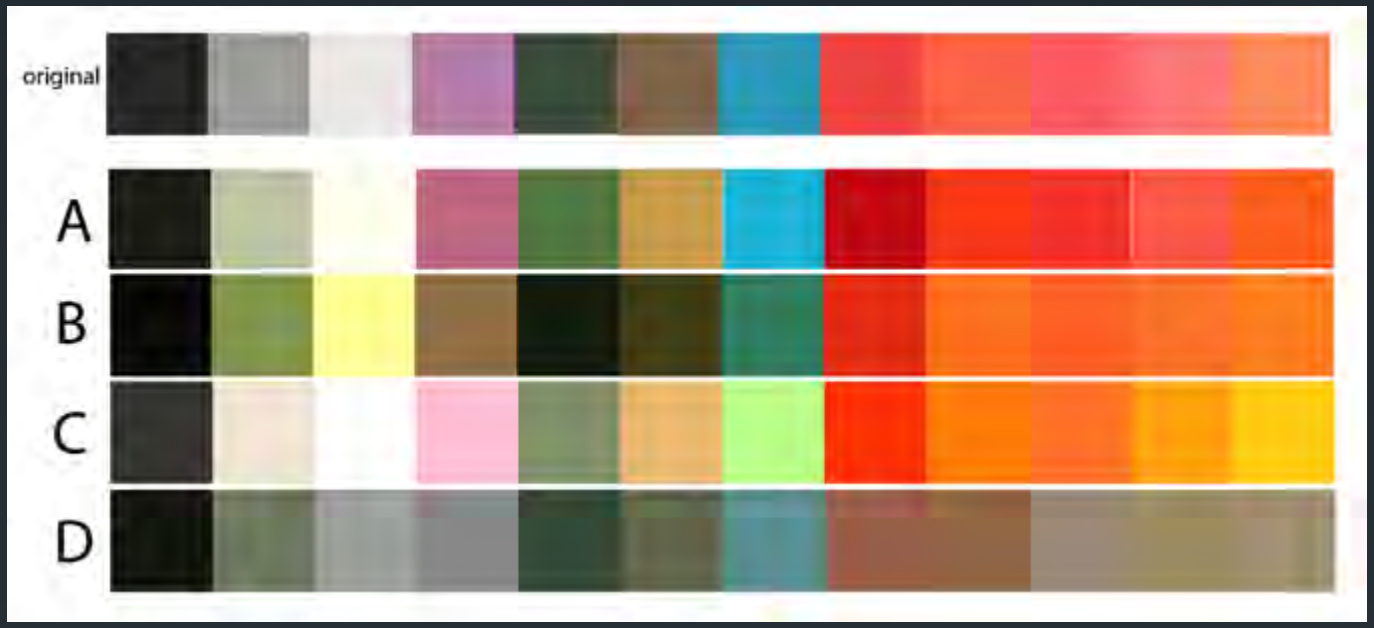
- Started with a known color targets, photographed each color patch inside a model eye with four different cameras

Quantified Changes

- Took what we knew of standard, and created our own profiles to remap colors to as close to standard as possible



Before



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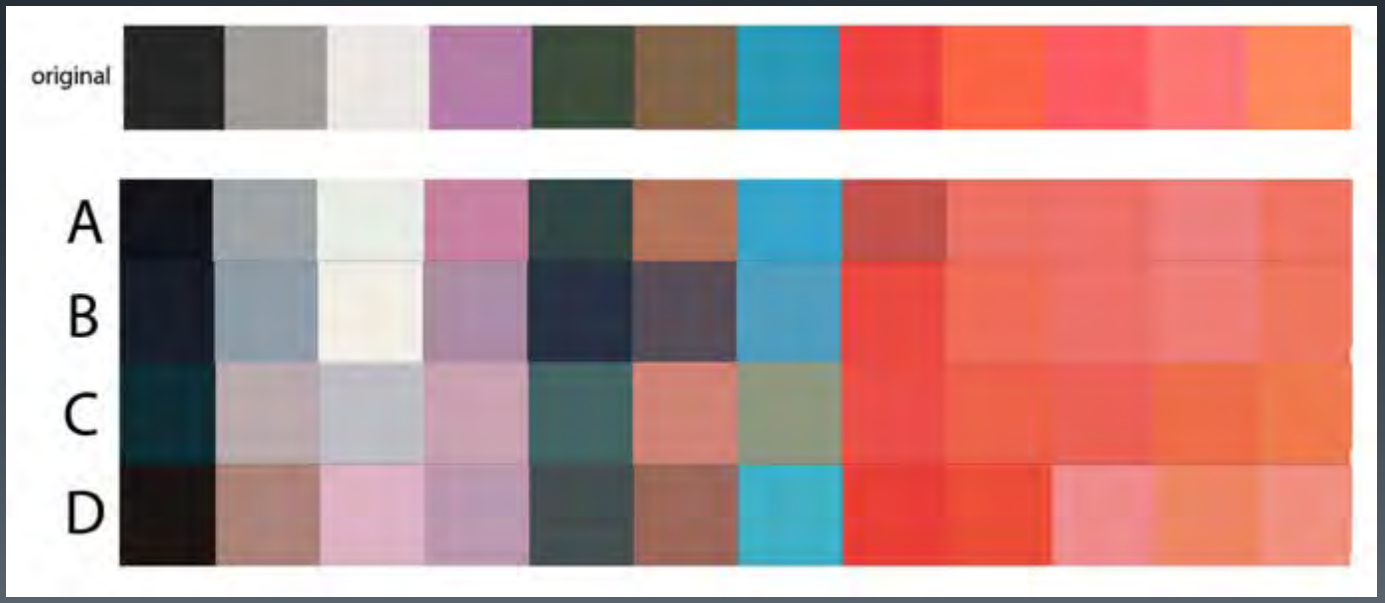
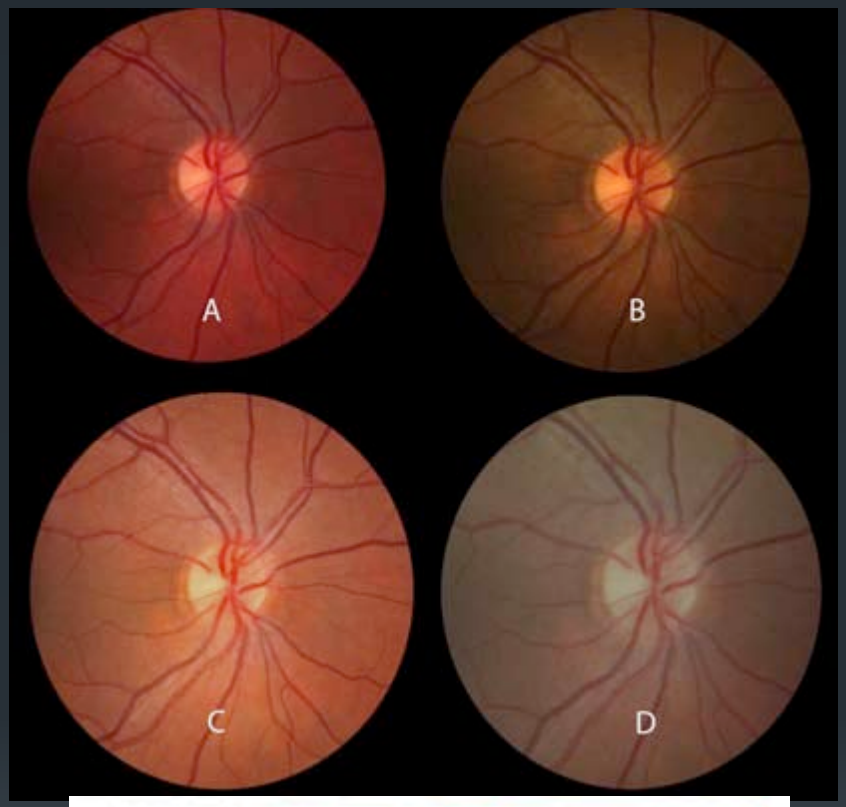


Captured vs. Processed



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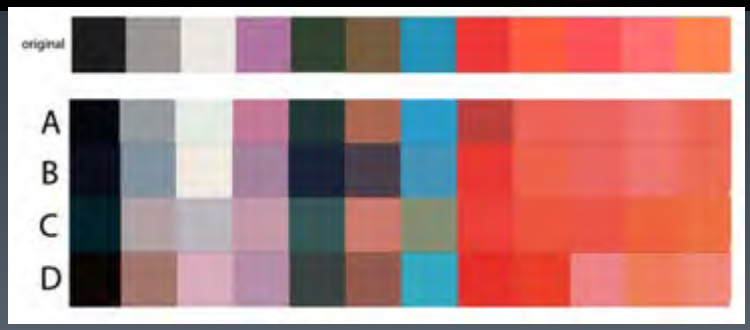


After

Phase I: Conclusions

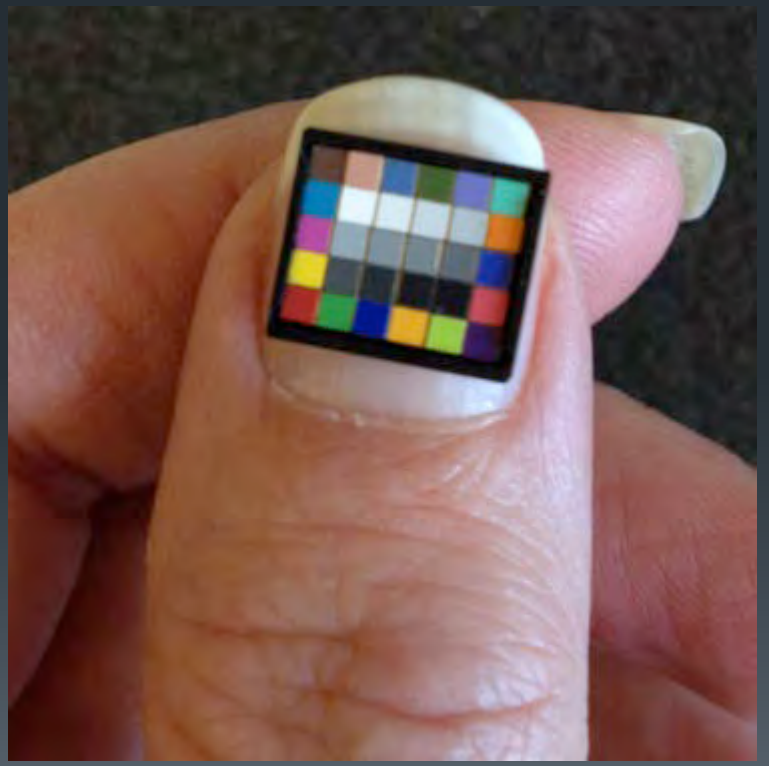
- It is potentially possible to profile a fundus camera, at least individually
  - Applying to RAW image in system would be ideal
- *What we as ophthalmic imagers and practitioners believe to be “correct” retinal color is not correct at all*
- A standard approach to color calibration is needed to mitigate input variables

Color Model Eye Project (MIWG) : Phase II

- Determine minimum color patch size
- Refine testing materials
  - Use of a standard color checker
  - Use of a aspherical model eye
- Determine imaging protocol
- Analyze results on TIFF vs RAW

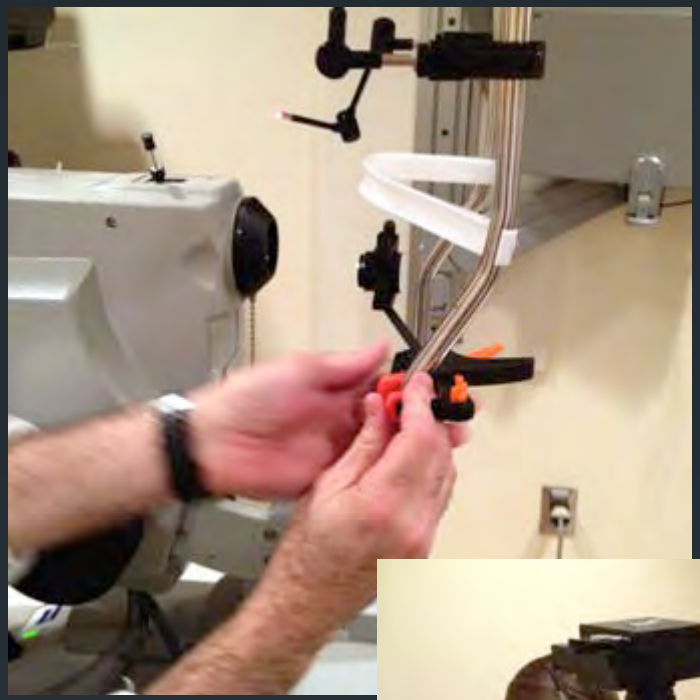
A Better Target (A really, really, really tiny Color Checker)

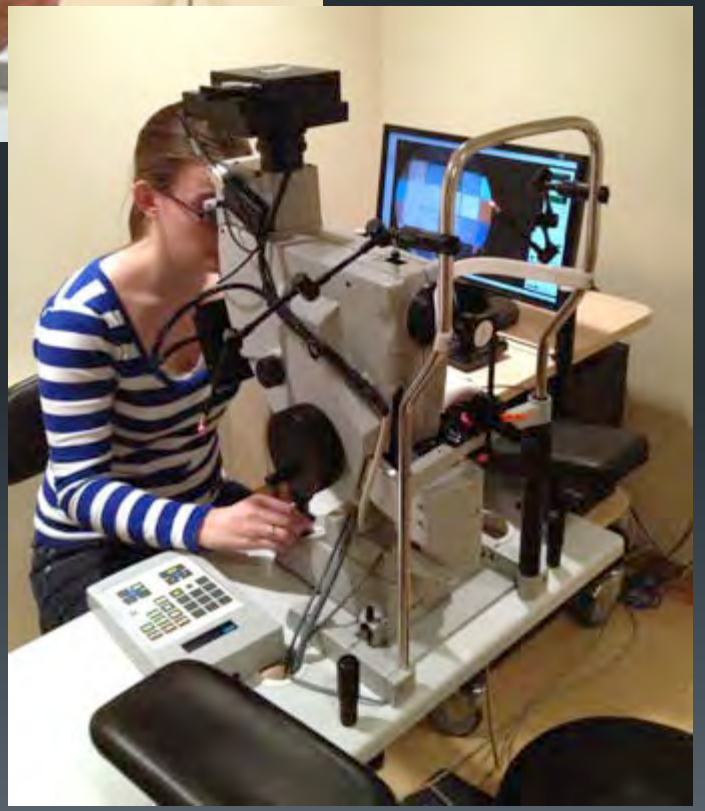
- Identical color patches to GretagMacbeth™ ColorChecker®, 1/12th original size
- Pigmented, painted samples
- Flat field

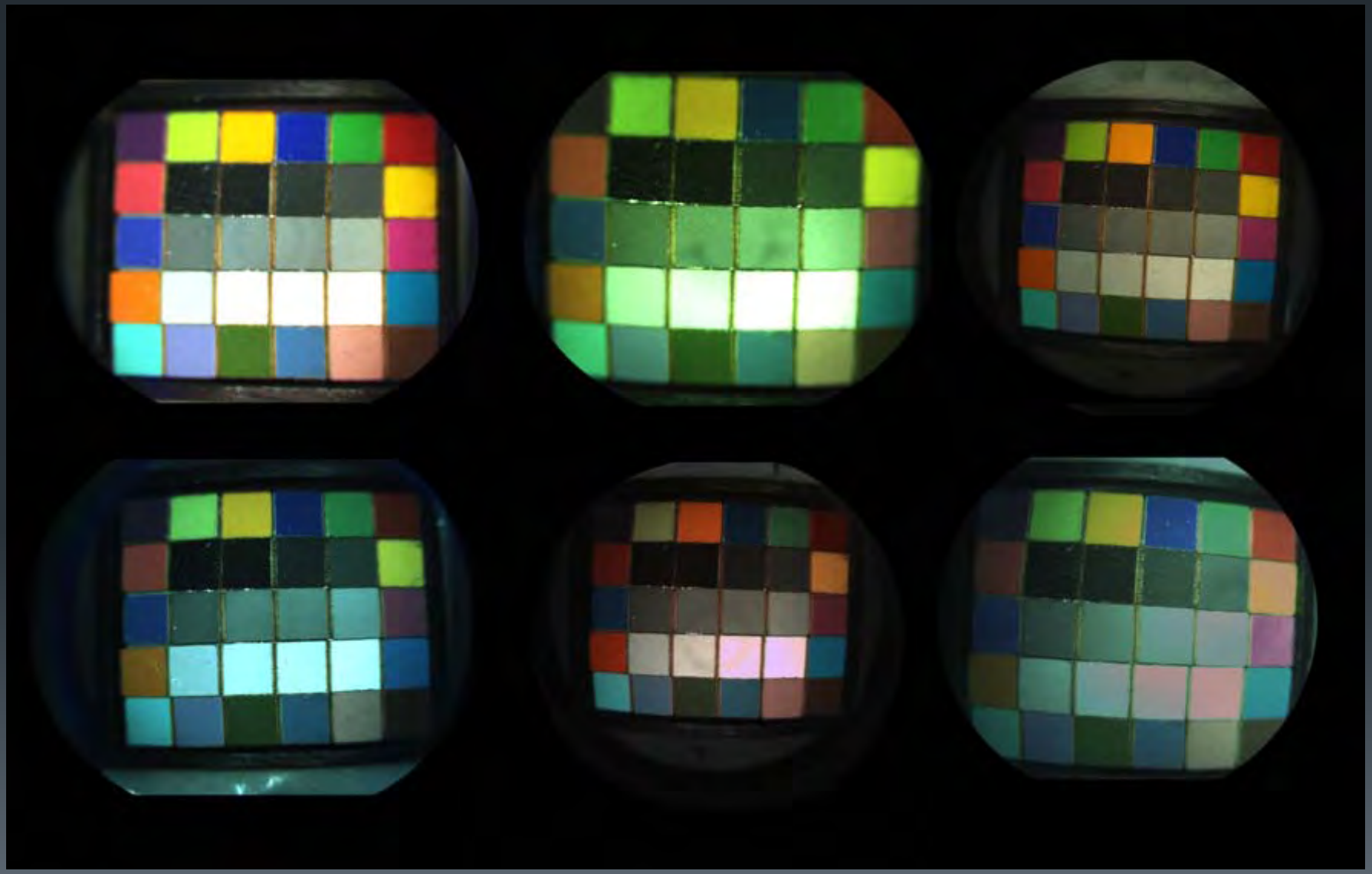


Protocol

- Inserted test target into model eye
- Chose “middle” angle of view
- Established proper alignment/working distance/focus
- Reduced/eliminate viewing illumination
- Captured at “normal” exposure, +/-







Findings and Discussion

- Illumination/exposure ratio issue
- What impact does field of view have? Flat field?
- Color of the inside of model eye?
- Exposure consistency?
- RAW vs. exported TIFF?

Phase III…

- Modify color patches, model eye if needed
- Extended camera testing at multiple sites
- Software implementation strategies
- Final feasibility report
  - Manufacturer vs. User implementation

Thanks to:

Color Model Eye Group Members

- Bill Fischer *Flaum Eye Institute, University of Rochester Medical Center*
- Jim Strong *Penn State Hershey Eye Center*
- Tim Bennett *Penn State Hershey Eye Center*
- Mark Fairchild *Munsell Color Science Laboratory, Rochester Institute of Technology*
- Susan Farnand *Munsell Color Science Laboratory, Rochester Institute of Technology*
- Matt Carnavale *Sonomed/Escalon*
- Kevin Langton *Carl Zeiss Meditec*
- Rich Amador *Canon*
- Dennis Thayer
- And Katelyn Donovan *RIT Photographic Sciences '14*

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