Clinical Application of Adaptive Optics Retinal Imaging Incubator Meeting
Break Out Session Topics

Session Title: Data Analysis, Extraction, and Delivery
Moderators: Dan Hammer and Austin Roorda

Part A: (~15 minutes). What information needs to be collected to convince the FDA to accept AO imaging data as a biomarker? Use the FDA guidance to answer the question.

Part B: (~30 minutes). Design a 1-page report to be produced by a black box AO retinal imaging system. What information is on the report? What does the report look like? The following questions provide guidance to direct detailed discussions on possible components of a report. Use the CZMI Cirrus output report as an example.

Questions:

1. Performance metric. Clinical reports from OCT imaging systems have a score from 1 to 10, derived from SNR and other factors, which define to the clinician and operator when to trust the imaging and segmentation measures. This feedback may tell OCT operators to collect additional data or clinicians when to discount or exclude images from their diagnoses or analyses. What system and image-based signals (WS, SLO, eye position, pupil position, etc.) from an AO system should be used to define a similar image quality metric?
2. Automation. What aspects of image acquisition, synthesis and analysis can be automated in normal eyes and eyes with disease, and what are the potential pitfalls of automation? How do we use automation to get a global picture of ocular health when AO images necessarily collect information from only a small sample of retina?
3. Normative databases. List what data and disease categories should be included in an AO normative database. (Cone density vs. eccentricity is an obvious one, but there can and should be others: NFL bundle density vs. eccentricity, foveal AVZ size, capillary density, etc.). How many normal subjects should be included? Are there other factors, such as age, that should be accounted for in some disease categories?
4. Reporting. What other elements should the report include? How many different custom forms should there be?

Suggested Reading:

1. FDA guidance.
2. Huang G., Qi X, Chui TY, Zhong Z, and Burns SA, “A clinical planning module for adaptive optics SLO imaging,” Opt. Vis. Sci., 89(5), 593-601 (2012).
3. Garrioch R, Langlo C, Dubis AM, Cooper RF, Dubra A, and Carroll J, “Repeatability of In Vivo Parafoveal Cone Density and Spacing Measurements,” Opt. Vis. Sci., 89(5), 632-643 (2012).
4. CZMI Cirrus output report.

Session Title: System Design Priorities – The AO Black Box
Moderators: Steve Burns and Alf Dubra

System Design Priorities:
The goal of this session is twofold. First we will characterize those hardware/software features we think ANY clinical instrument should possess, and then those that would make sense to a majority of us, but would be involved in a cost-benefit tradeoff if we had to decide whether to purchase a commercial AO imaging device. We have provided examples in both areas below, but these are intended only as a way to get thinking started and in some cases are included because we expect the group to reject those "features". We are looking to develop a lively discussion, especially when we start to talk about what can really be accomplished in a clinical setting.

In the second phase, we will generate a list (and discuss) topics that also need to be developed in order to make AO retinal imaging truly useful. This second area could include hardware capabilities required for testing clinical import, but would not be necessary in a commercial system. For instance, in a research program it might be important to have an AO system that did both animals and humans, or that did both AO-OCT and AO-SLO, but this would be used to validate the ultimate clinical imaging (whatever mode it was). It is assumed that during this second phase of discussion there might be discussions among the group on the tradeoffs they have encountered.

Essential:
1. Lateral resolution of 3 microns (pupil size of 6 mm in near IR)
2. Single frame / video
3. Live high resolution field of view / Live large field of view
4. Single-person operation
5. Ability to work with arbitrary pupil shape (cortical spokes, capsular opacification, etc.)
6. Ability to work with intraocular lenses (multifocal, Fresnel lenses, etc.)
7. Ability to work with a chin and forehead rest (as opposed to a bite bar)
8. Safe for xx hours with what relation to the ANSI limits?
9. Other?

Desirable:
1. Pupil Camera
2. Ability to store information on the quality of wavefront control with an image?
3. Auto Focus
4. Snake Imaging and automatic montages (at the right focus)
5. Automatic blood flow quantification measurements. Large vessels? Capillaries?
6. Automatic capillary mapping?
7. Eye tracking – how good
8. Confocal Imaging / Variable confocality
9. Multimode (OCT, SLO, polarimetry, fluorescein angiography, ICG angiography, lipofuscin fluorescence, etc.)
10. Multi-wavelength / Simultaneous multi-wavelength / Preferred or highly desirable wavelengths
11. Psychophysics (stimulus delivery)
12. Cone classing
13. Functional imaging (oxygenation changes in tissue, etc.)
14. Other?

Suggested Reading:
1. Roorda, A. et al. "Adaptive optics ophthalmoscopy), Ch. 9, Retinal Imaging
2. Roorda, A., Miller, D.T., Christou, J. "Strategies for High-resolution retinal imaging"

Session Title: What Does AO Give You That Existing Clinical Tools Don't?
Moderators: Jacque Duncan and Nagahisa Yoshimura

In this session, we will focus on answering the following questions, which are geared at addressing the unique needs of a clinical instrument.

Questions:

1. What are the relative advantages of each modality with respect to AO – Flood vs OCT vs SLO?
2. Are there particular diseases that benefit more from AO?
3. How can AO info/images best be placed in a clinical context:
    a. How will data be integrated with other modalities (from a technical standpoint)?
    b. How will the data acquired from AO be integrated with existing clinical data – how to correlate AO images with standard clinical tests of retinal structure and function?
4. What are the best ways to make AOSLO more accessible to non-engineers:
    a. Ways to facilitate and expedite image integration and interpretation for clinicians?
    b. Ways to facilitate and enable rapid, reliable data acquisition for clinical staff (eye photographers and technicians). Can it be acquired automatically?
5. What sort of minimum imaging protocol might exist (think about ISCEV protocols for electrophysiology and the various OCT protocols)?

Suggested Reading:

1. Chui etal. "The use of forward scatter to improve retinal vascular imaging with an adaptive optics scanning laser ophthalmoscope" BOEx, 2012
2. Ooto et al. "High-Resolution Photoreceptor Imaging in Idiopathic Macular Telangiectasia Type 2 Using Adaptive Optics Scanning Laser Ophthalmoscopy" IOVS, 2011
3. Talcott et al. "Longitudinal Study of Cone Photoreceptors during Retinal Degeneration and in Response to Ciliary Neurotrophic Factor Treatment" IOVS, 2011
4. Tam et al. "Disruption of the Retinal Parafoveal Capillary Network in Type 2 Diabetes before the Onset of Diabetic Retinopathy" IOVS, 2011
5. Wojtkowski, M., Kaluzny, B., Zawadzki, R. J. "New Directions in Ophthalmic Optical Coherence Tomography" OVS, 2012