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High-speed/Long-time, High-Resolution/Large-Fields In Vivo Imaging By 4K/8K CMOS Sensors without Trade-Off factors

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We utilized 4/8K CMOS sensors, and non-linear optics, which enabled broader imaging field, longer observation time, and deeper imaging, also with conventional spatial and time resolutions. Usually, always “trade-off” for every imaging factors (ex. time versus spatial resolutions).We escaped from these dilemma by large-size CMOS sensors. We utilized low-power and high-NA-number immersion lens with correction of mismatch indexes. Amount of information per time was increased up to 1TB/1hr. These system covered micro- to macro-scale in time and space, which enabled us to track single cell for long time with sub-micro resolutions. Optical path was enlarged optimized for large CMOS sensors, and pixel numbers. Same approach was applied for two photon systems, and also for handy size imagers.

We have two applications.

1: Visualization of thrombus formation by intravital vessel imaging

To visualize dynamically developing thrombus and vascular responses, which is one of the main components of cardiovascular diseases, we performed intravital vessel visualization. We covered single platelet dynamics for micro and organ size imaging field for macro scale. We revealed platelet behaviors and platelet morphological changes at micro level (sptatial resolution: 250nm, time resolution: mili-seconds), and cellular network responses at macro organs scale (imaging seize 30mm,x30mm x10mm, observation time: one night). In addition to platelet activation in millisecond order, and inflammatory reactions in hours are simultaneously evaluated by single imaging modality. We showed that each neutrophils were accumulated to repair “leak” of blood into lymphatic stromal spac. Zooming factors were adjusted and animals were moved by XYZ stepping (coarse/slow) and XYZ piezo (fine/fast) systems for tracking single cells.

2: Whole-Eye imaging

Another approach is 4K 2P resonance scanners. By adjusting refractive index for long light path in mice, whole eye and retina imaging can be performed using x10 to x40 objective lenses. Imaging depth exceeded 3mm, but we clearly visualized angiogenic responses after delivery in new born mice. Rapid blood flow dynamics, and slow remodeling processes are also evaluated in single modality.

In sum, we covered micro to macro scale in space and time dimensions for intravital observation technique by 4K/8K CMOS sensors. We are now trying next approach, near and deep infrared wavelength.

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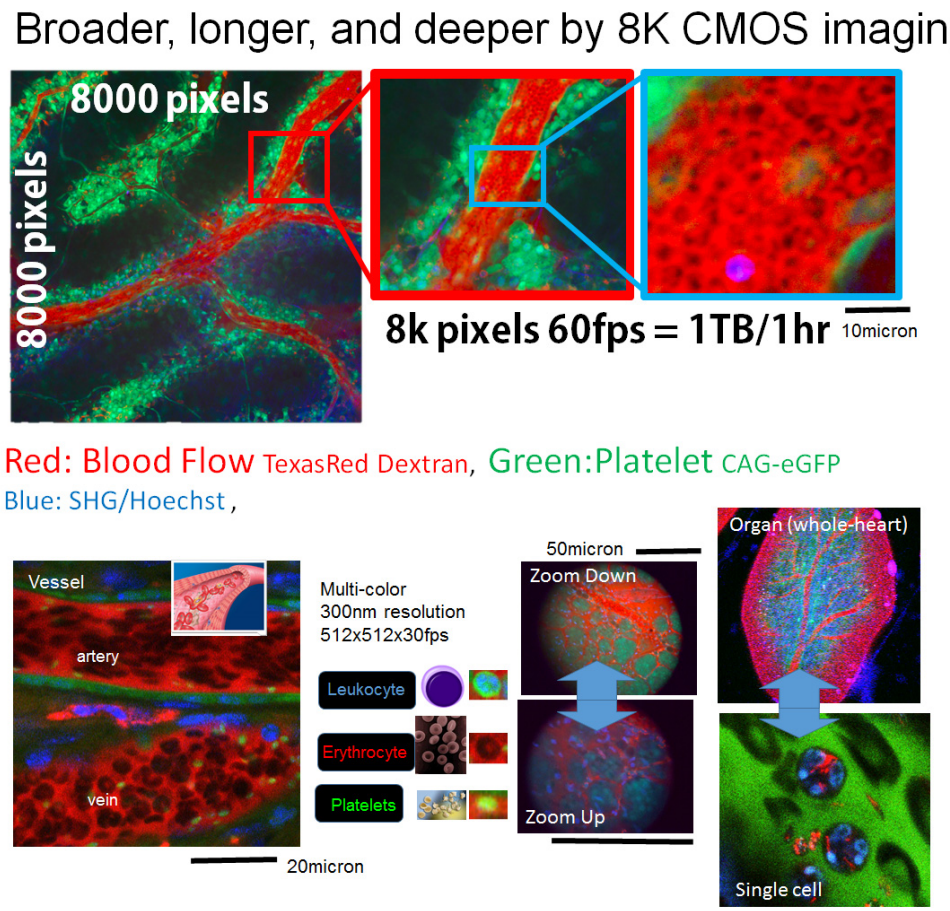

Fig 1.Mulsi-scale in vivo imaging for thrombus formation

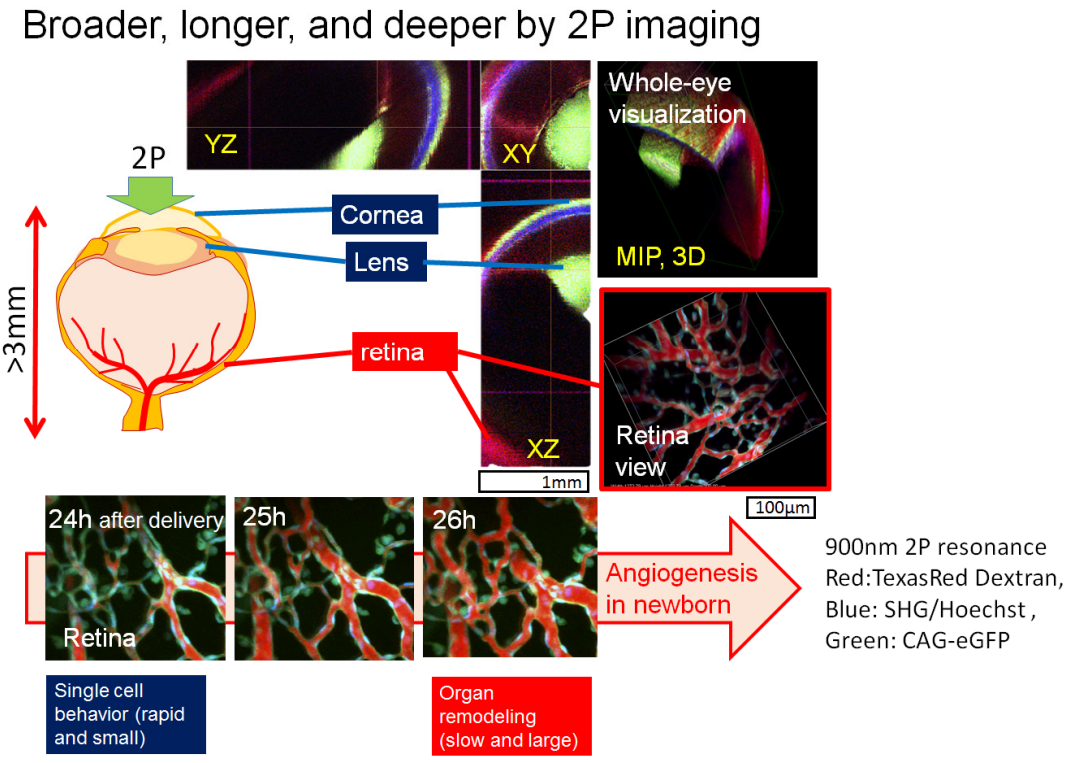

Fig 2. Whole-eye in vivo imaging

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