

Breakout Session 1: Track B

Cloud Computing for Optical Image Restoration and Intramural Training

Dr. Johnny Tam (Moderator), Senior Investigator, NIH/NEI

Dr. Vineeta Das, Postdoc, NIH/NEI

Dr. Jiamin Liu, Staff Scientist, Advanced Imaging and Microscopy (AIM) Resource, NIH

Cloud Computing for Optical Image Restoration and Intramural Training

Johnny Tam, Jiamin Liu, and Vineeta Das

NEI, NIBIB, and AIM

Intramural Research Program, National Institutes of Health

Objectives

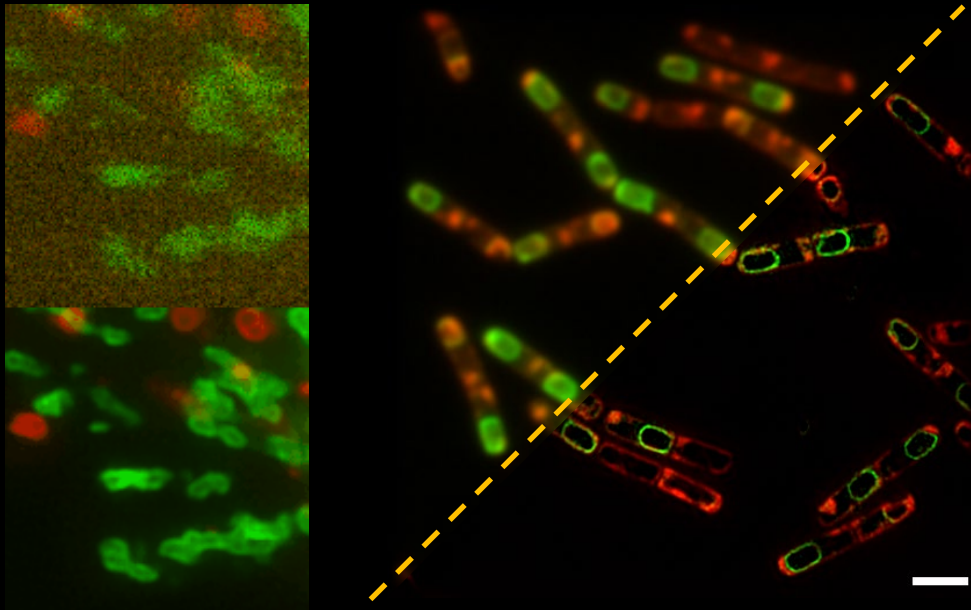
1. Develop and apply artificial intelligence-based methods to imaging datasets in the cloud.
2. Train the next generation of data scientists by creating a small community of cloud users interested in optical imaging and microscopy.

Part 1: Cloud computing for optical microscopy

Jiamin Liu

Advanced Imaging and Microscopy (AIM) Resource

Deep Learning to Denoise and Enhance Resolution for Super Resolution Imaging




Advanced Imaging and Microscopy Resource (AIM)
NIBIB, NIH

ARTICLES <https://doi.org/10.1038/s41592-021-01155-x> nature | methods

Check for updates

Three-dimensional residual channel attention networks denoise and sharpen fluorescence microscopy image volumes

Jiji Chen^{1,10}, Hideki Sasaki^{2,3,10}, Hoyin Lai^{2,3,10}, Yijun Su^{1,2,3,4,10}, Jiamin Liu¹, Yicong Wu⁴, Alexander Zhovmer⁵, Christian A. Combs⁶, Ivan Rey-Suarez^{7,8}, Hung-Yu Chang^{2,3}, Chi Chou Huang^{2,3}, Xuesong Li⁴, Min Guo⁴, Srineil Nizambad¹, Arpita Upadhyaya^{7,8,9}, Shih-Jong J. Lee^{2,3}, Luciano A. G. Lucas^{2,3,11} and Hari Shroff^{1,4,11}

nature biotechnology 

Article <https://doi.org/10.1038/s41587-022-01651-1>

Three-dimensional structured illumination microscopy with enhanced axial resolution

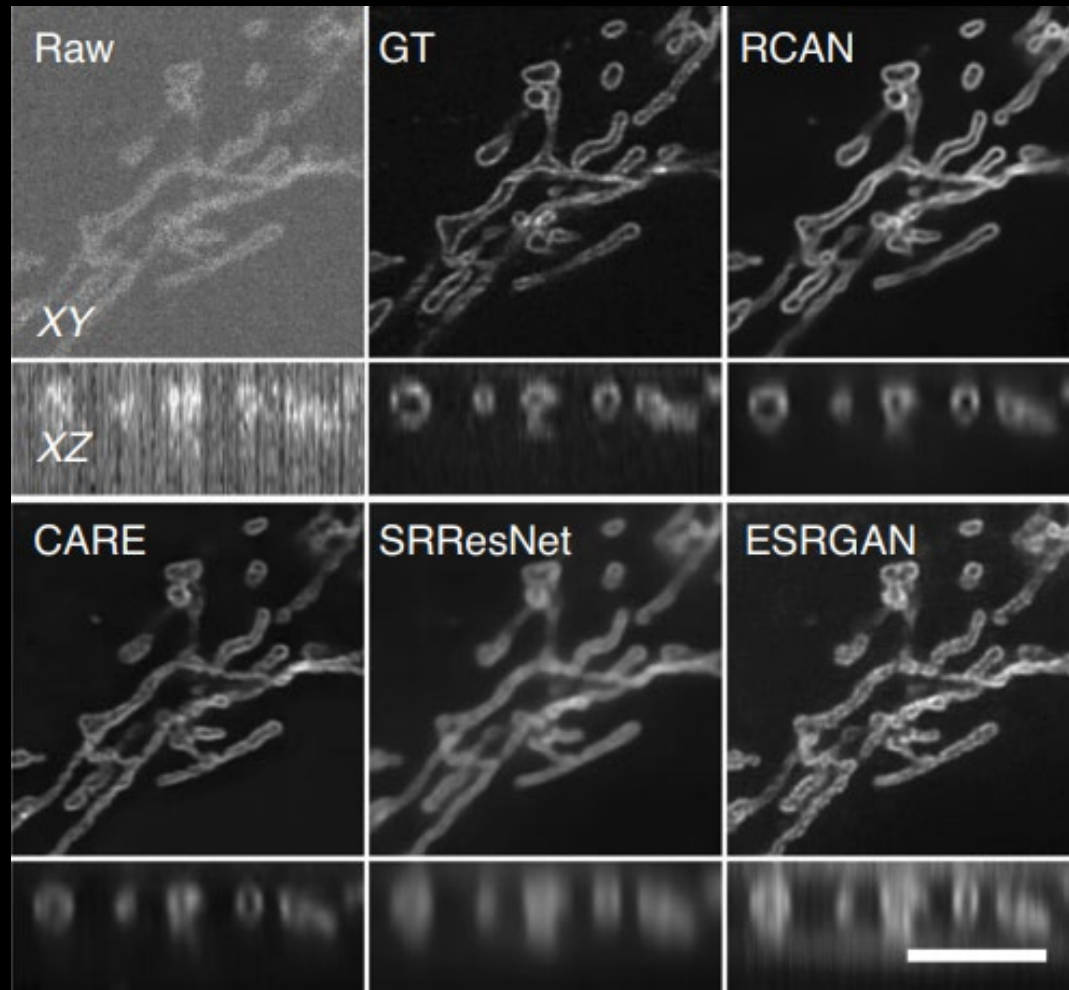
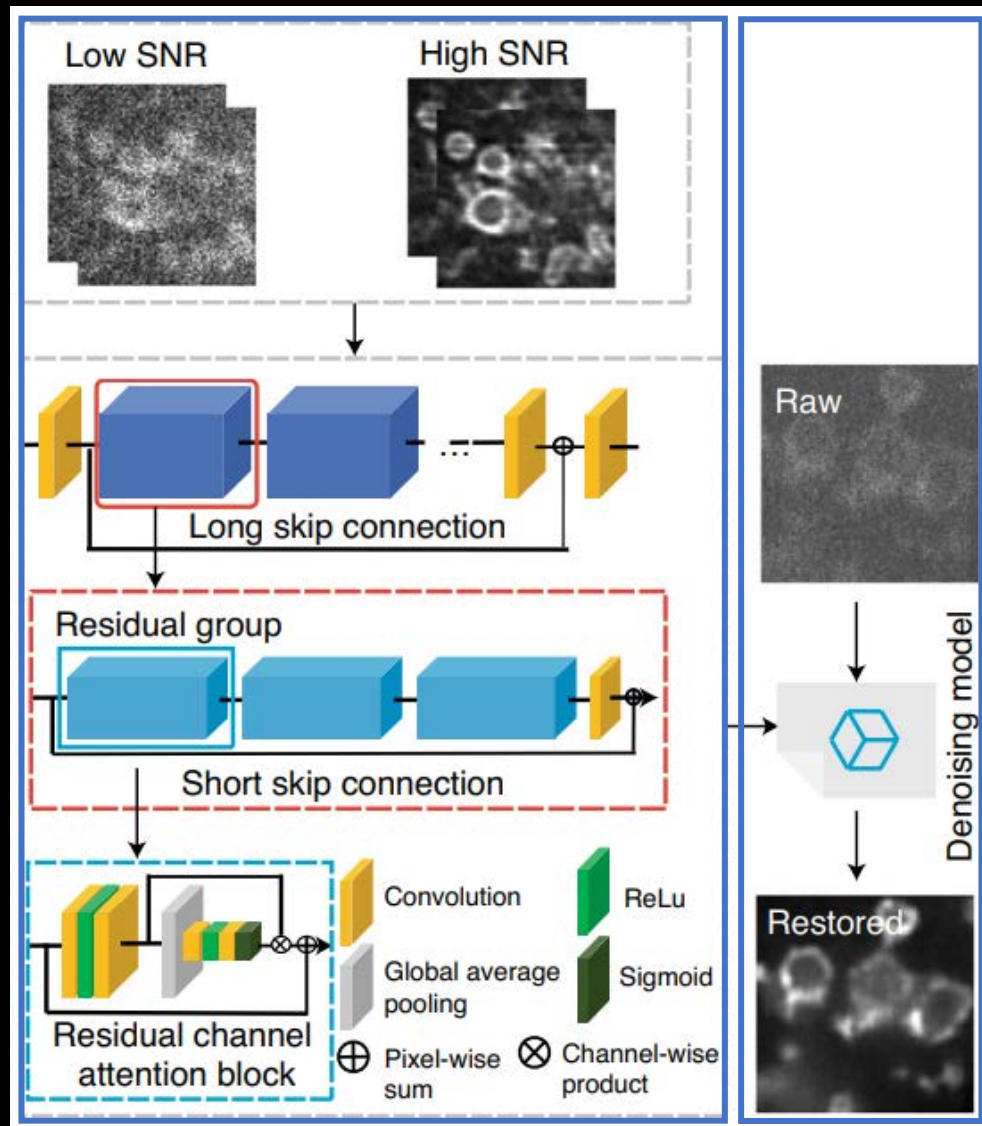
Received: 15 August 2022
Accepted: 16 December 2022
Published online: 26 January 2023

Check for updates

Xuesong Li^{1,14}, Yicong Wu^{1,2}, Yijun Su^{1,2,3,4,14}, Ivan Rey-Suarez⁵, Claudia Mattheaus⁶, Taylor B. Updegrave⁷, Zhuang Wei⁸, Lixia Zhang², Hideki Sasaki^{3,4}, Yue Li⁹, Min Guo^{1,15}, John P. Giannini¹, Harshad D. Vishwasrao², Jiji Chen², Shih-Jong J. Lee^{3,4}, Lin Shao¹⁰, Huafeng Liu⁹, Kumaran S. Ramamurthi⁷, Justin W. Taraska⁶, Arpita Upadhyaya^{5,11}, Patrick La Riviere^{12,13} & Hari Shroff^{1,2,13,14}

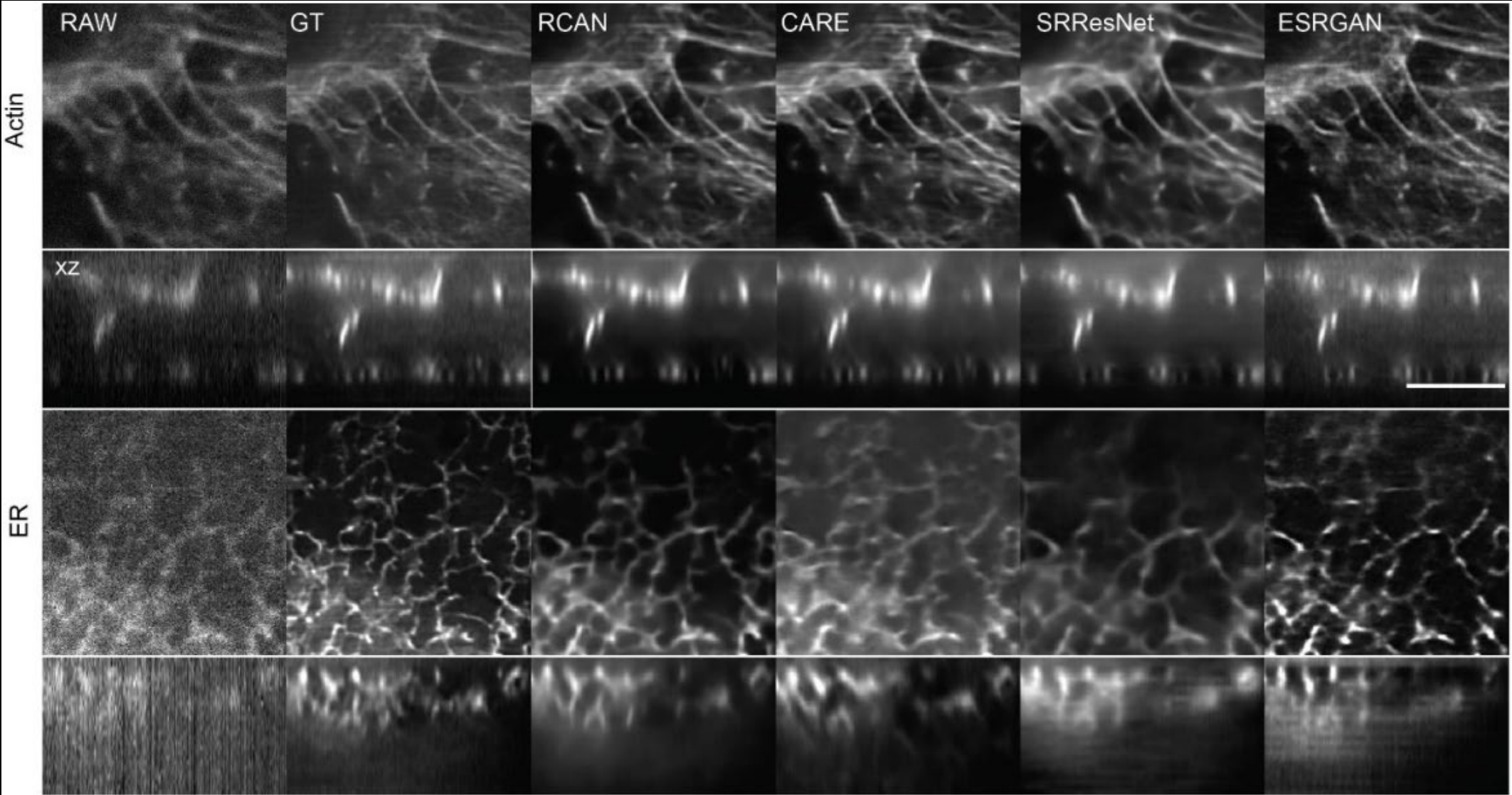
Training

Testing

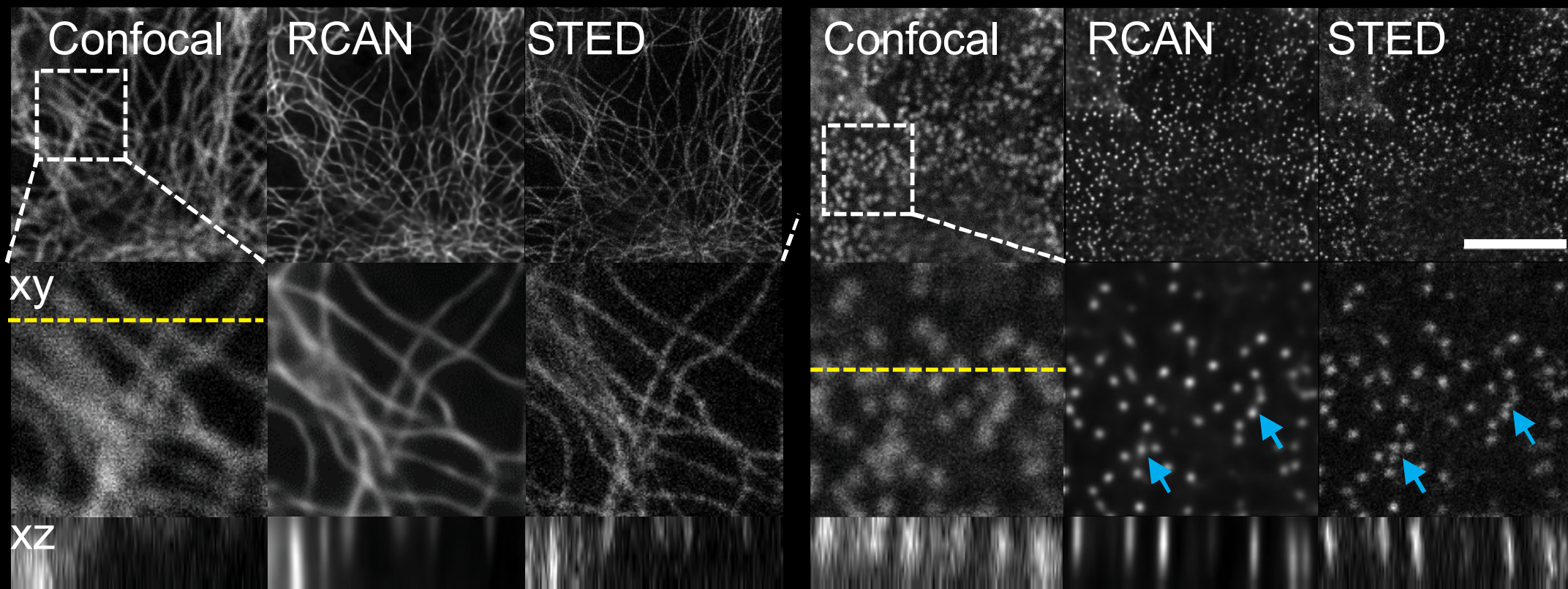


CARE: Content-aware image restoration Nat Methods. 2018 Dec;15(12):1090-1097.
 ESRGAN: Enhanced super resolution generative adversarial network arXiv:1809.00219v2
 SRResNet: Super resolution ResNet arXiv:1609.04802v5

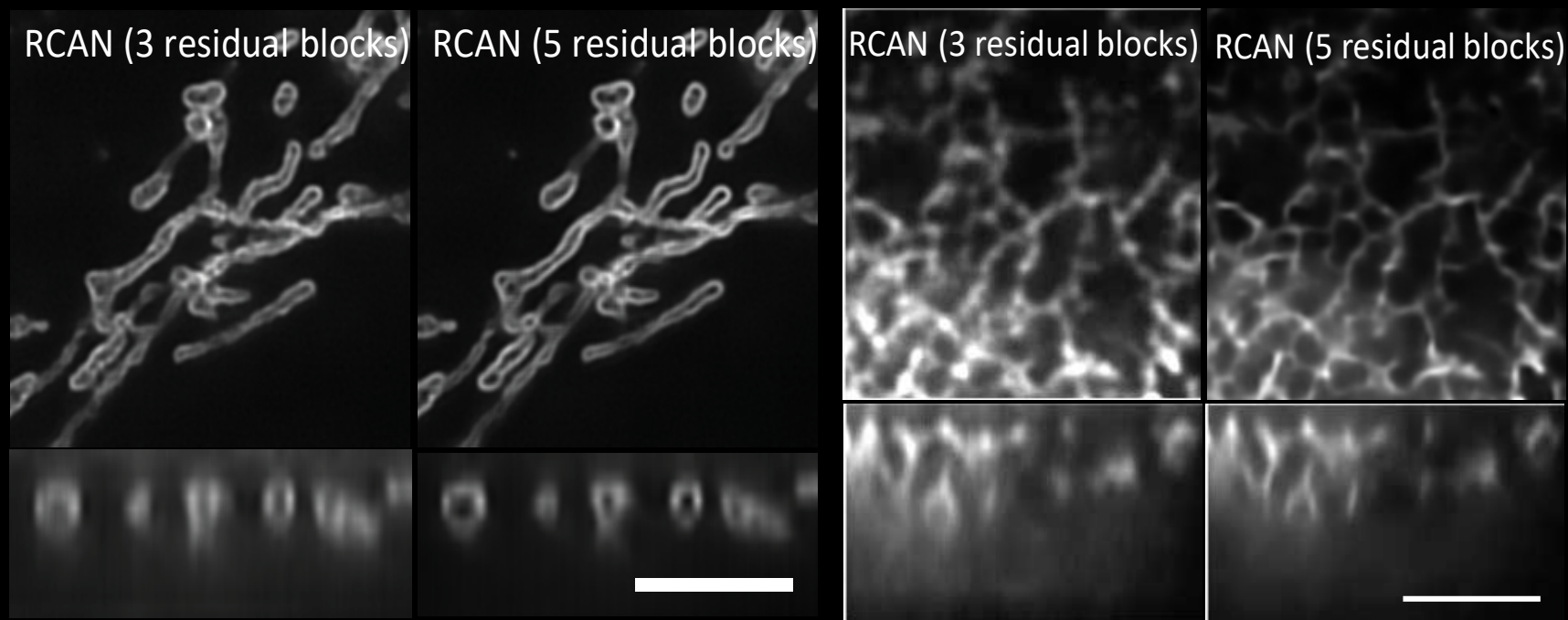
RCAN vs State-of-Art Methods



Cross Imaging Modality: Confocal to STED



Hyperparameters Tuning



More residual blocks increase 3D RCAN performance.
It requires much more training time and high-end GPU.

Three-dimensional structured illumination microscopy with enhanced axial resolution

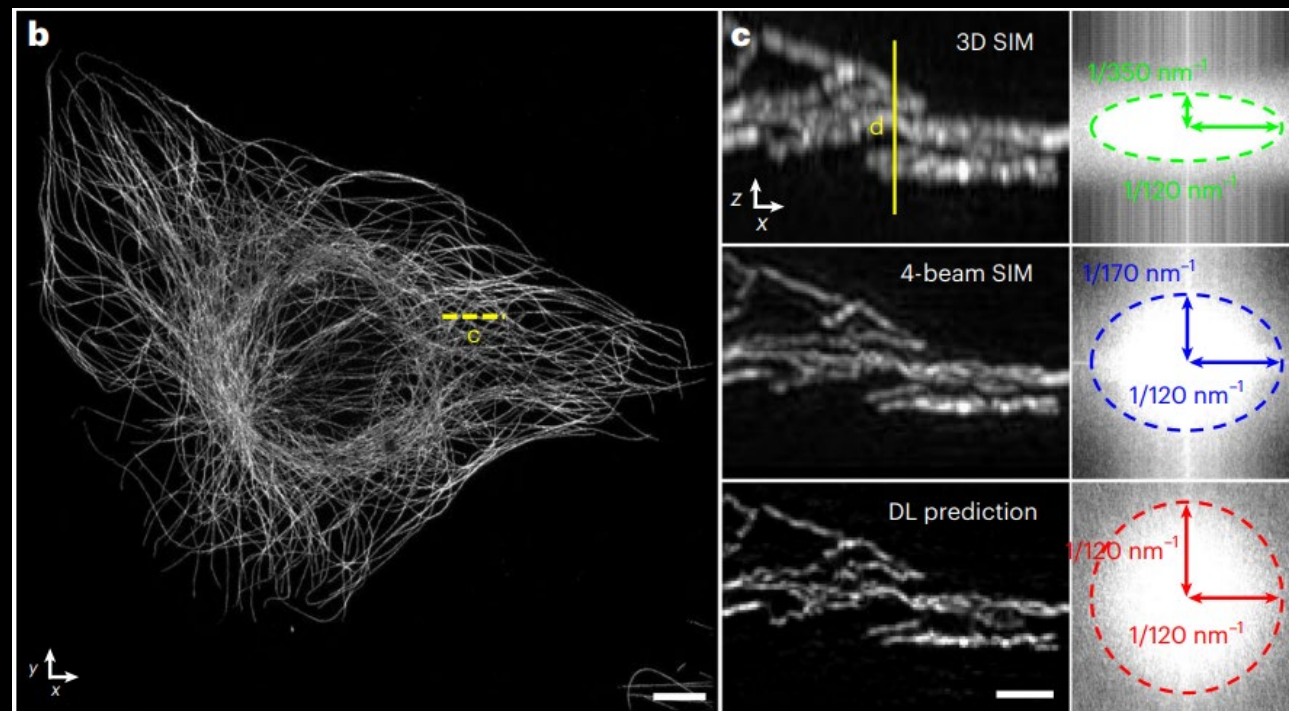
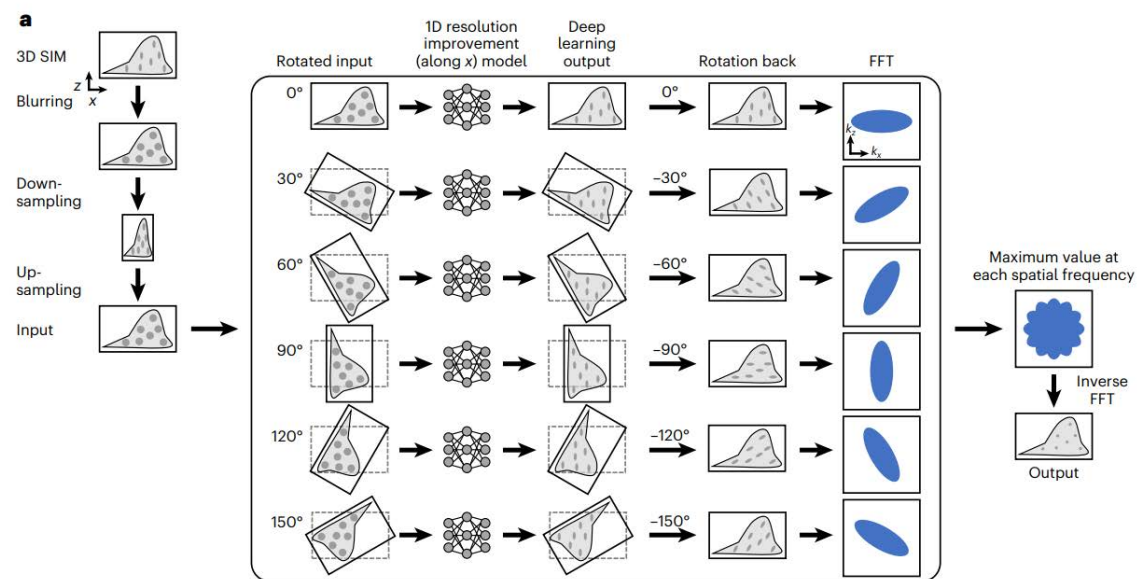
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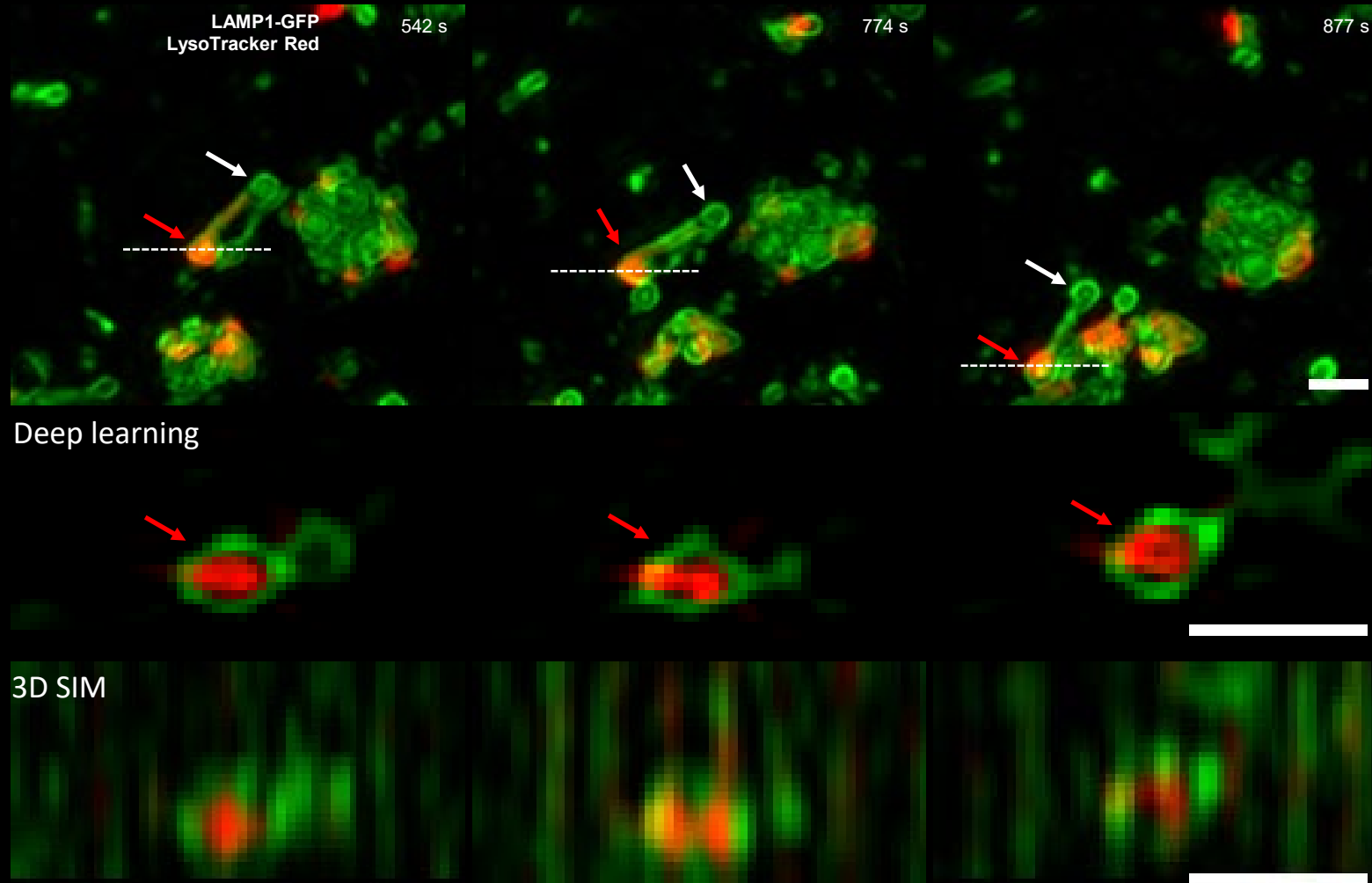
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Xuesong Li^{1,14}✉, Yicong Wu^{1,2}✉, Yijun Su^{1,2,3,4,14}, Ivan Rey-Suarez⁵, Claudia Matthaeus⁶, Taylor B. Updegrave⁷, Zhuang Wei⁸, Lixia Zhang², Hideki Sasaki^{3,4}, Yue Li⁹, Min Guo^{1,15}, John P. Giannini¹, Harshad D. Vishwasrao², Jiji Chen², Shih-Jong J. Lee^{3,4}, Lin Shao¹⁰, Huafeng Liu⁹, Kumaran S. Ramamurthi⁷, Justin W. Taraska⁶, Arpita Upadhyaya^{5,11}, Patrick La Riviere^{12,13} & Hari Shroff^{1,2,13,14}



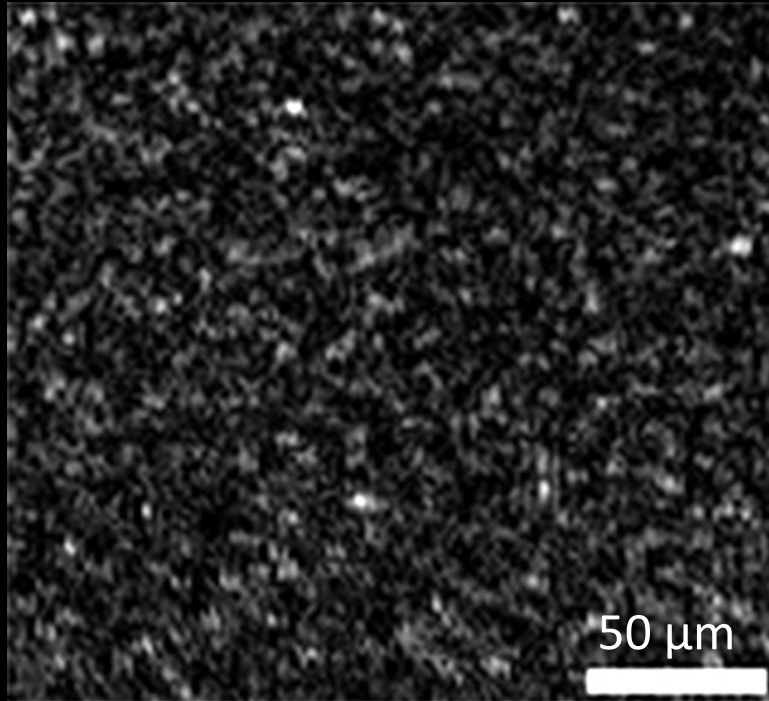
DL Enables 120 nm Isotropic Resolution



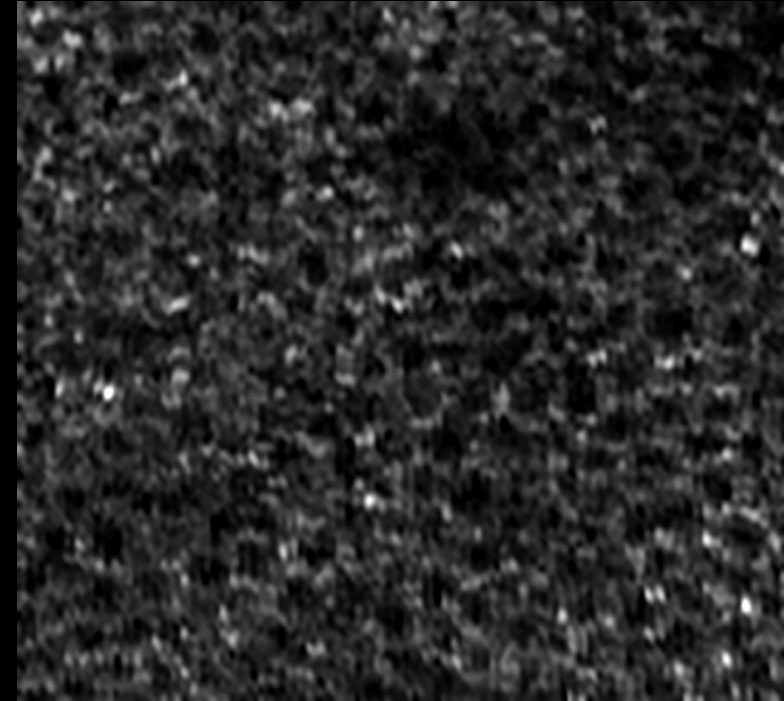
Part 2: Cloud computing for optical imaging in the eye

Vineeta Das
National Eye Institute

Imaging of the RPE cells

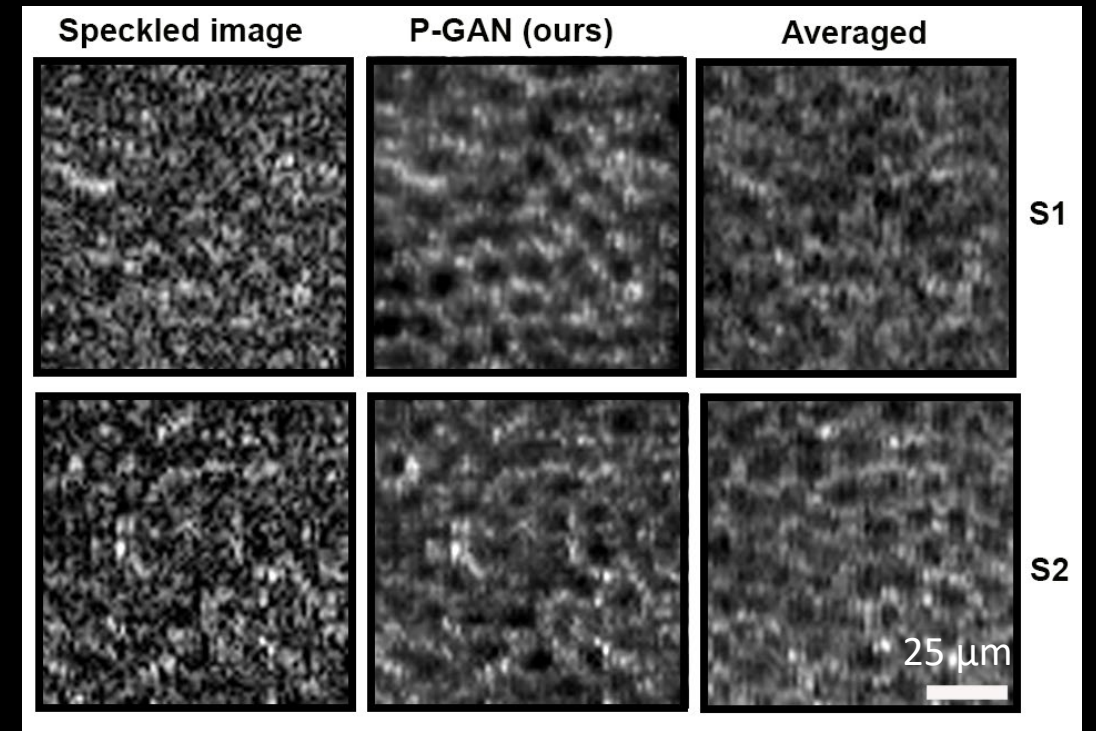
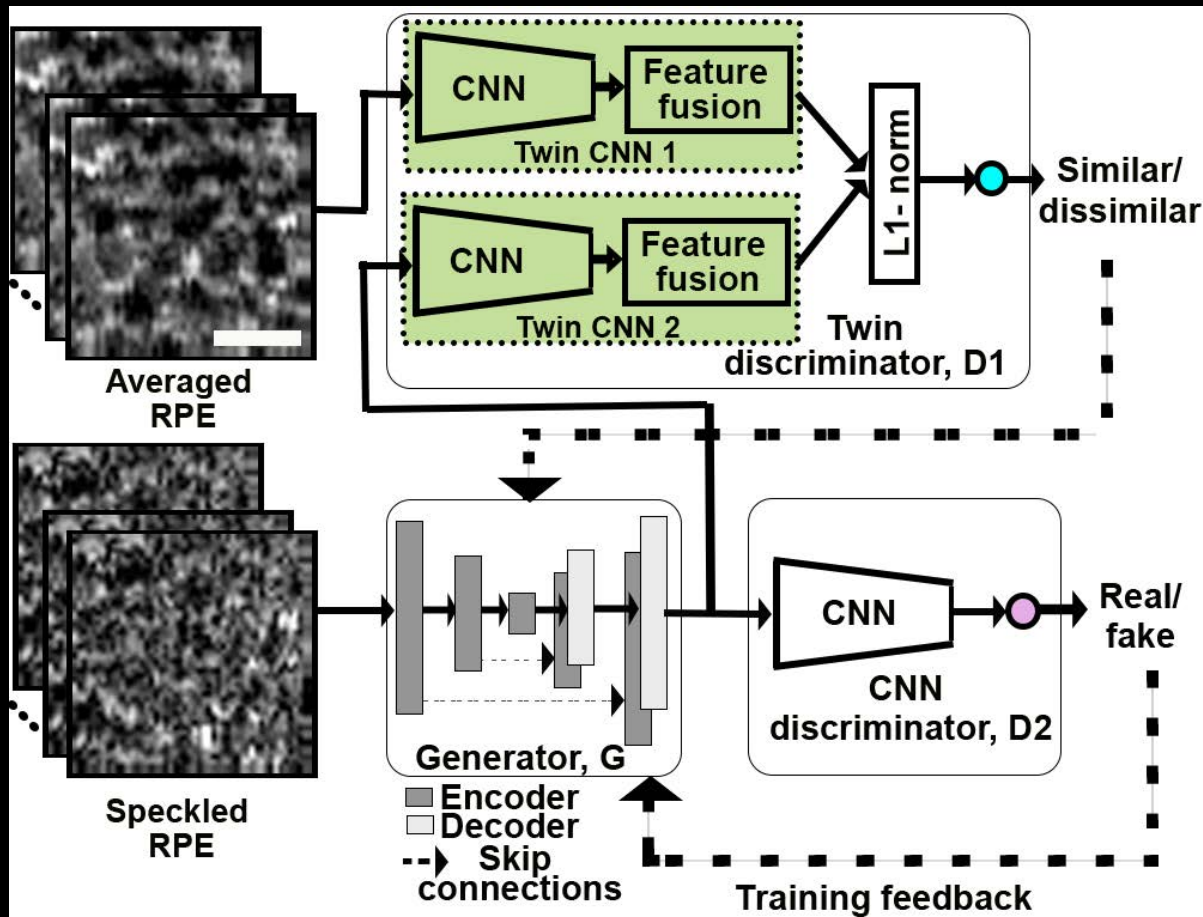


Noisy image of RPE cells
Single acquisition



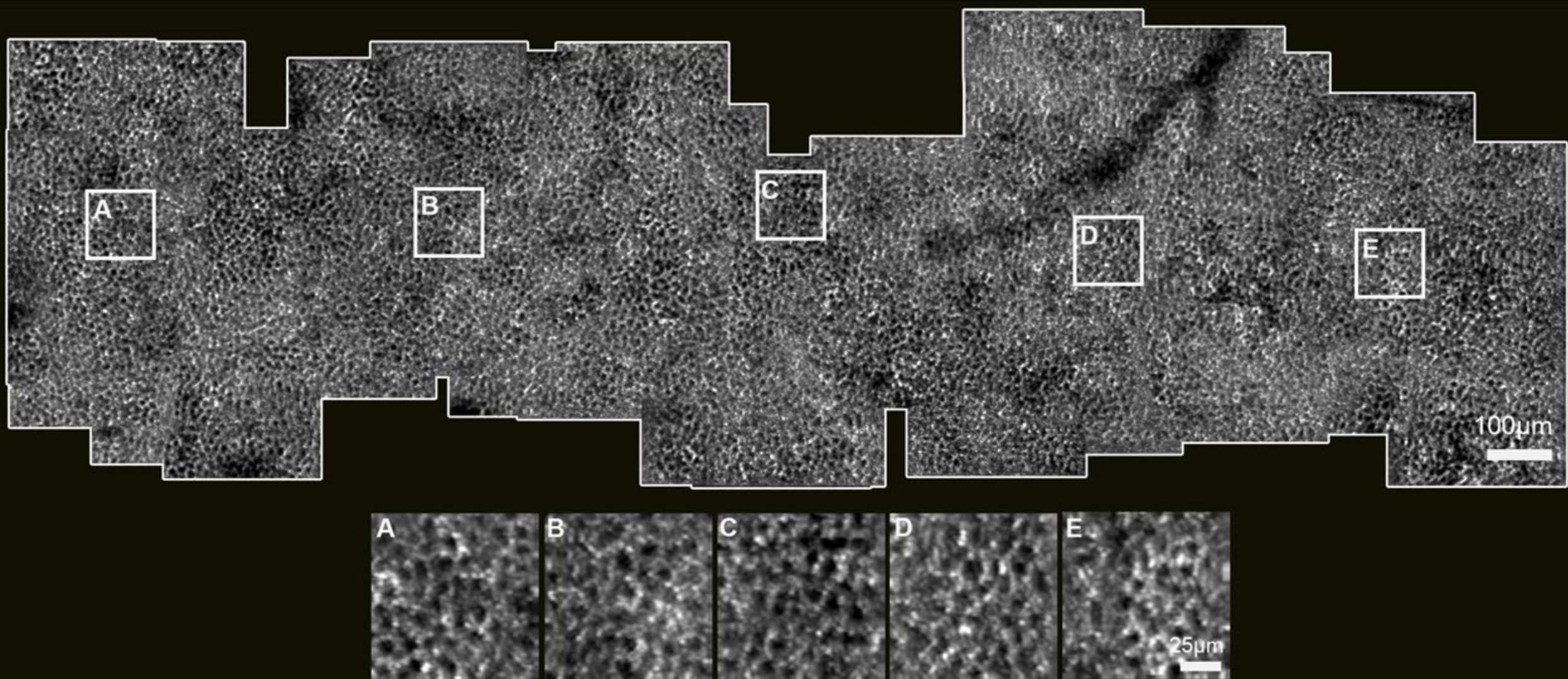
Average of 120 acquisitions

Parallel discriminator GAN (P-GAN) for RPE recovery

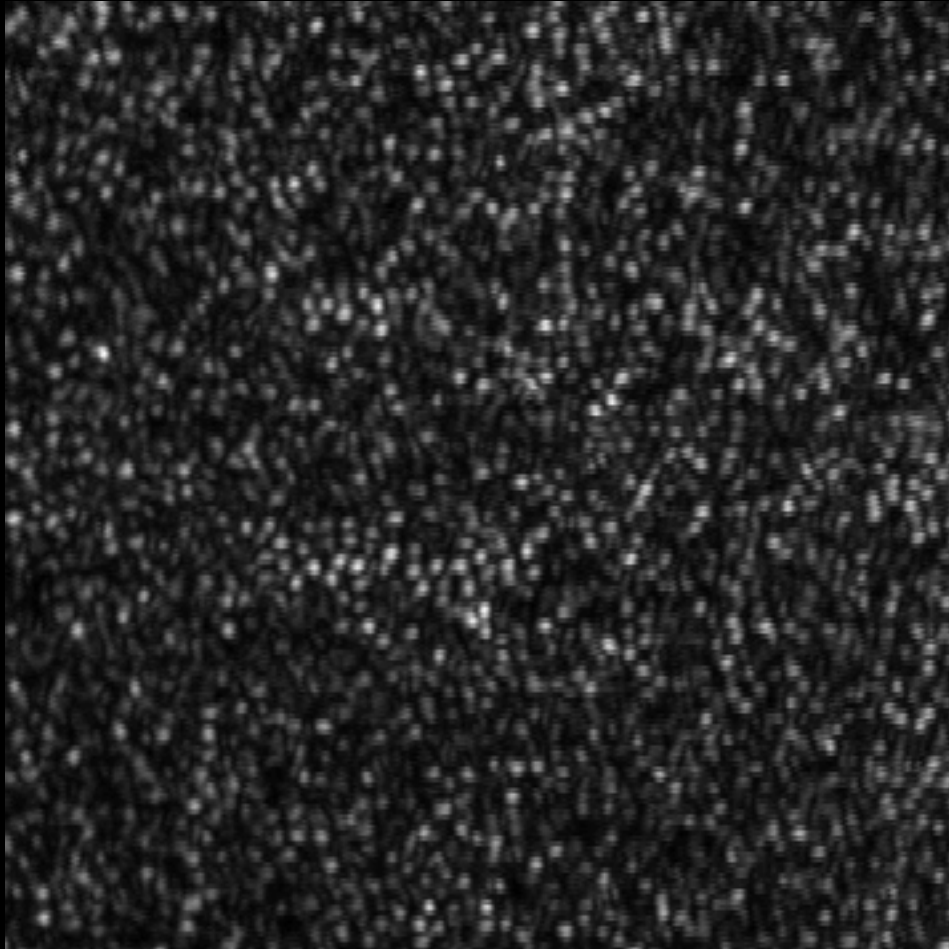


*S1 and S2 represent subjects

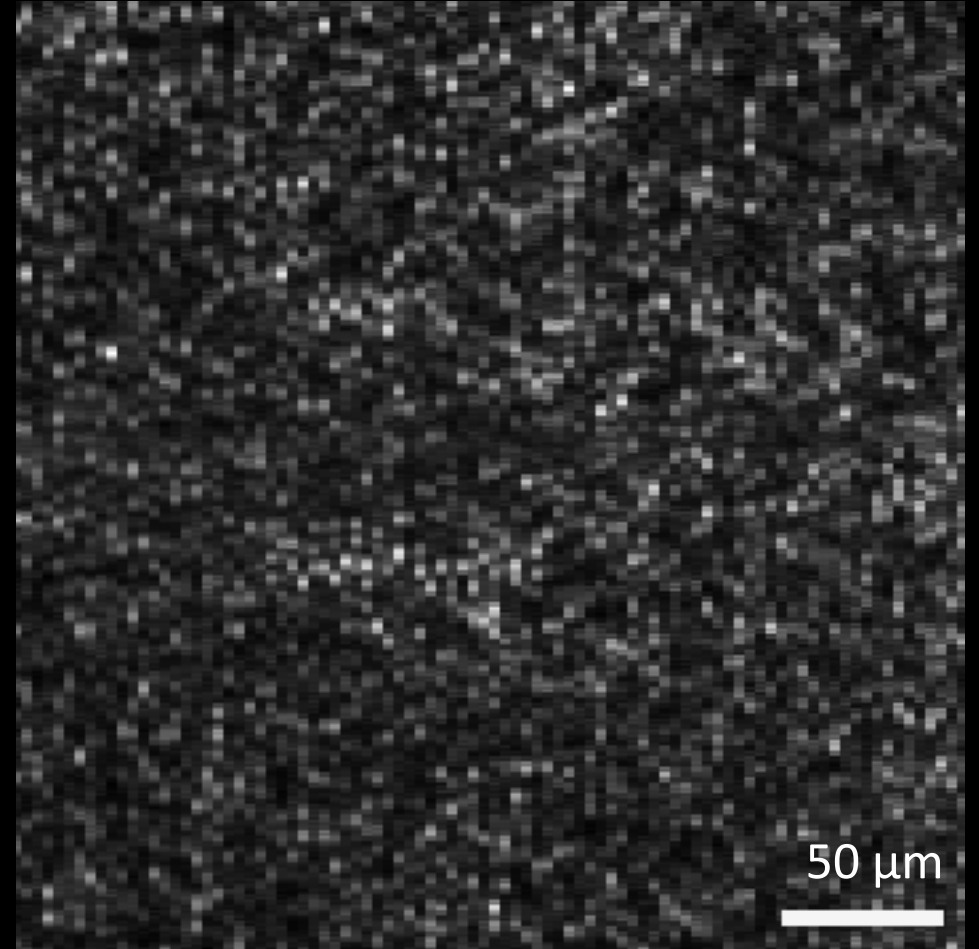
AI assisted imaging enables large scale RPE visualization



Imaging of the cone photoreceptors



Dense sampling (DS)
Cone photoreceptors



Sparse sampling (SpS)

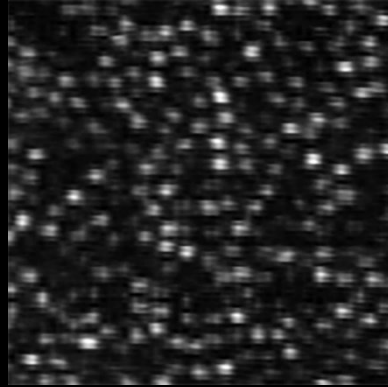
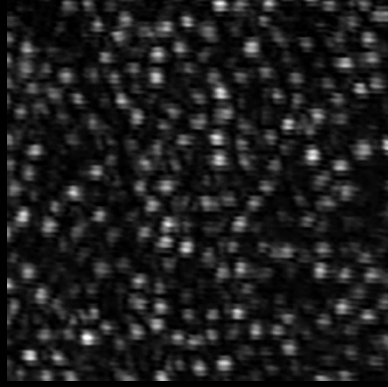
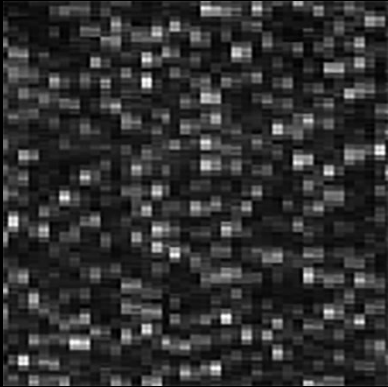
Results

SpS

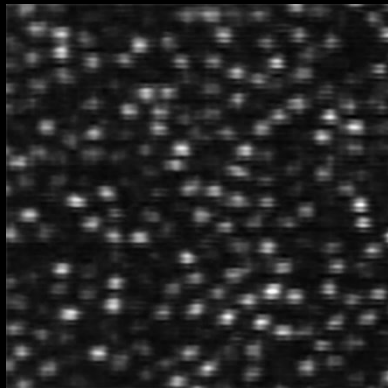
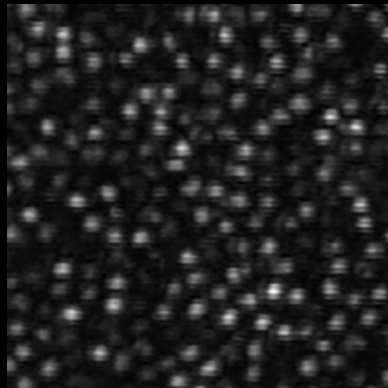
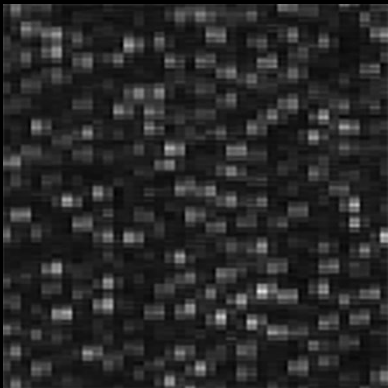
DS

AI

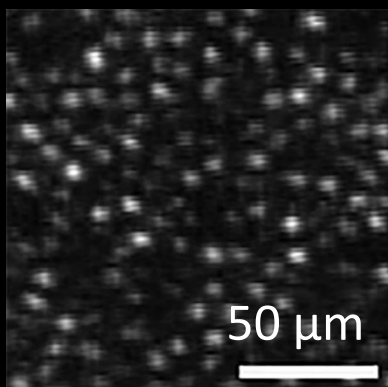
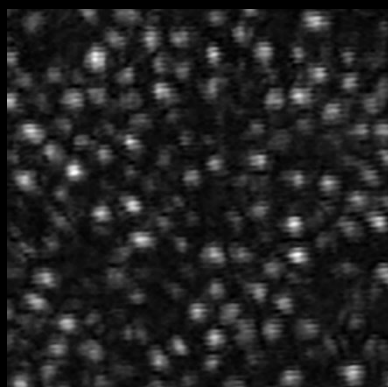
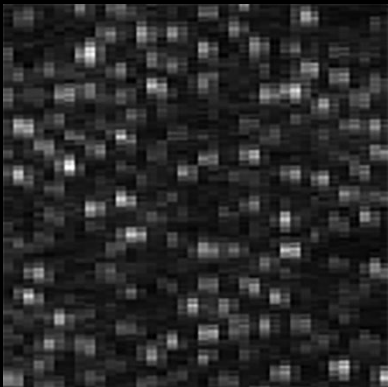
L1



L2



L3



Estimated cell spacing (μm)

Location	DS	AI
L1	11.5	11.3
L2	9.8	10.2
L3	8.3	8.0

L1, L2, and L3 denote regions of interest imaged at 1.5 mm, 2.1 mm and 2.7 mm temporal to the fovea, respectively.

Acknowledgements

Current members

AIM / NIBIB

Harshad Vishwasrao

Jiji Chen

Jiamin Liu

NEI

Andrei Volkov

Tao Liu

Previous members

Hari Shroff

Yicong Wu

Xuesong Li

Bruno Alvisio

Jianfei Liu

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