Supplementary Material for A Poisson-Gaussian Denoising Dataset with Real Fluorescence Microscopy Images

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1. Fluorescence microscopy setup

The confocal and two-photon images were acquired with a Nikon A1R-MP laser scanning confocal microscope equipped with a Nikon Apo LWD 40×, 1.15 NA water-immersion objective. The confocal and two-photon images were 512×512 pixels with a pixel size of 300 nm and a pixel dwell time of 2 µs. The A1R-MP microscope has multiple detectors (PMTs) in parallel, so for multi-channel (color) fluorescence imaging with the BPAE cells, all three images were acquired simultaneously. For confocal imaging, the excitation was generated by a LU4/LU4A laser unit, the pinhole size was set to 1.2 Airy unit, and the imaging conditions for different samples were as follows: BPAE nuclei, 405 nm excitation, 0.5% laser power, 110 PMT gain; BPAE F-actin, 488 nm excitation, 0.5% laser power, 110 PMT gain; BPAE mitochondria, 561 nm excitation, 0.5% laser power, 110 PMT gain; mouse brain, 405 nm excitation, 0.5% laser power, 115 PMT gain; zebrafish embryo, 488 nm excitation, 10% laser power, 140 PMT gain. For two-photon microscopy, the excitation was generated by a Spectra-Physics Mai Tai DeepSee femtosecond laser, and for all two-photon images, the laser power was set to 0.5%, the PMT gain to 130, and the excitation wavelength to 780 nm. Note that our dataset did not include two-photon images of the zebrafish sample because during two-photon imaging, very strong two-photon auto-fluorescence signals from the zebrafish were observed, which severely degraded the imaging quality.

The wide-field images were acquired with a Nikon Eclipse 90i wide-field fluorescence microscope equipped with a Nikon Plan Fluor 40×, 0.75 NA objective. The excitation was generated by a halogen lamp (with ND16 neutral-density filter) and the images were captured by a DS-Fi1-U2 camera with an exposure time of 200 ms and a gain of 46. The raw image size was 1280×960 and the pixel size was 170 nm. These images were cropped to 512×512 before being processed for our dataset. Note that our dataset only covered wide-field images of the BPAE cells because wide-field microscopy could not image well in animal tissues such as mouse brain and zebrafish embryo, where strong out-of-focus fluorescence would blur out the wide-field images. Since the BPAE cells were stained with three different fluorophores while only one detector (CCD camera) was available in the 90i microscope, we imaged three times for the same FOV, each time with a different filter block (DAPI for nuclei, FITC for F-actin, TRITC for mitochondria), to acquire the multi-channel (color) fluorescence image of the cells.

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2. Pixel clipping or over/under-exposure

In fluorescence microscopy, under-exposure is not an issue due to the high sensitivity and accuracy of microscopy detectors. However, pixel clipping or over-exposure could be inevitable because distinct biological structures with various optical properties could generate extremely bright fluorescence signals, which saturated the detector and caused pixel clipping. We tried to avoid pixel clipping by manually adjusting the detector gain. As a result, at most 0.2% of pixels were clipped in all imaging configurations, as shown in Table 1 (averaged percentages). Consequently, the clipped pixels could introduce bias when we estimated the ground truth by image averaging. Considering the negligible proportion of clipped pixels, our ground truth images maintain an accuracy higher than 99.8%.

3. Benchmark results on separate test set

Here we show the benchmark results on the 19-th FOV (which is pre-selected as the test set) for each imaging configuration and each noise level, which contains 50 noise realizations in each case. The results are organized in Table 2 (confocal), 3 (two-photon), and 4 (wide-field). For all test

Table 1. Percentages of clipped pixels to all pixels in the images.

Mod.	Samples	Raw (%)	GT (%)
CF	BPAE (Nuclei)	0.002343	0
CF	BPAE (F-actin)	0.004214	0.000629
CF	BPAE (Mito)	0.000013	0
CF	Zebrafish	0.186157	0.038757
CF	Mouse Brain	0.015899	0.000057
TP	BPAE (Nuclei)	0.169477	0.001450
TP	BPAE (F-actin)	0.006969	0.000515
TP	BPAE (Mito)	0.000346	0.000172
TP	Mouse Brain	0.151986	0.008736
WF	BPAE (Nuclei)	0.123395	0.000153
WF	BPAE (F-actin)	0.000311	0
WF	BPAE (Mito)	0.000037	0

cases, deep learning based denoising methods almost dominate over traditional methods.

4. Network architecture and training details

Network We try our best to maintain the same network structure of DnCNN and Noise2Noise as the original papers. For N2N-BN model, we modify the Noise2Noise model by inserting batch normalization layer after each convolution layer and adding Tanh activation before the network output. For more details, please refer to the official implementations of DnCNN[1] and Noise2Noise[2].

Training Input images are of size 256×256, normalized to the range $[-0.5, 0.5]$. Adam optimizer is used with hyperparameters $\beta_1 = 0.9, \beta_2 = 0.99$, weight decay 0.0. The learning rate scheduling follows the one cycle policy[3], with maximum learning rate to be 0.0001, initial learning rate to be $1/10$ of the maximum rate, then linearly increasing the learning rate to the maximum within 0.3 of the total epochs, then cosine annealing of the learning rate to $1/10^5$ of the maximum learning rate. The model is trained for 400 epochs. All the settings above are the same for both DnCNN and Noise2Noise.

The minibatch size is 16 for both DnCNN and Noise2Noise. We randomly sample 4 noisy images for DnCNN (4 pairs of large noisy images for Noise2Noise) of size 512×512 from the training set and crop each large image into 4 non-overlapping patches of size 256×256, thus the mini-batch size is actually 16.

[1] `https://github.com/cszn/DnCNN`

[2] `https://github.com/NVlabs/noise2noise`

[3] `https://github.com/fastai/fastai/blob/master/fastai/callbacks/one_cycle.py`

Confocal Microscopy		Number of raw images for averaging					
Samples	Methods	1	2	4	8	16	Time
BPAE (Nuclei)	VST+NLM	37.35 / 0.9656	38.20 / 0.9730	39.31 / 0.9810	41.11 / 0.9862	43.68 / 0.9906	129.92 s
	VST+BM3D	38.45 / 0.9732	39.59 / 0.9786	40.95 / 0.9853	42.37 / 0.9889	44.37 / 0.9918	5.13 s
	VST+KSVD	38.15 / 0.9699	39.48 / 0.9773	40.92 / 0.9850	42.30 / 0.9888	44.32 / 0.9919	65.90 s
	VST+KSVD(D)	37.77 / 0.9679	39.26 / 0.9762	40.82 / 0.9846	42.28 / 0.9887	44.28 / 0.9918	20.25 s
	VST+KSVD(G)	38.07 / 0.9694	39.39 / 0.9767	40.87 / 0.9847	42.28 / 0.9886	44.20 / 0.9917	17.11 s
	VST+EPLL	38.38 / 0.9731	39.47 / 0.9785	40.85 / 0.9854	42.35 / 0.9891	44.42 / 0.9920	246.47 s
	VST+WNNM	38.43 / 0.9734	39.55 / 0.9784	40.91 / 0.9851	42.28 / 0.9885	44.21 / 0.9914	417.71 s
	PURE-LET	37.15 / 0.9583	38.55 / 0.9688	40.15 / 0.9795	41.55 / 0.9843	43.51 / 0.9887	2.43 s
	DnCNN	38.91 / **0.9795**	40.23 / **0.9834**	**41.62** / **0.9872**	**43.07** / **0.9903**	**44.97** / **0.9930**	**2.37** s
	Noise2Noise	**39.13** / 0.9771	**40.29** / 0.9823	41.47 / 0.9858	42.73 / 0.9885	44.21 / 0.9907	2.69 s
BPAE (F-actin)	VST+NLM	32.80 / 0.8419	34.28 / 0.8893	35.76 / 0.9237	37.37 / 0.9462	39.39 / 0.9624	134.04 s
	VST+BM3D	34.07 / 0.8880	35.38 / 0.9168	36.74 / 0.9395	38.15 / 0.9556	39.80 / 0.9675	6.42 s
	VST+KSVD	33.33 / 0.8565	34.81 / 0.8985	36.25 / 0.9291	37.65 / 0.9484	39.17 / 0.9614	287.22 s
	VST+KSVD(D)	32.88 / 0.8412	34.49 / 0.8892	36.07 / 0.9245	37.55 / 0.9460	39.11 / 0.9598	64.16 s
	VST+KSVD(G)	33.08 / 0.8465	34.62 / 0.8914	36.14 / 0.9248	37.60 / 0.9457	39.17 / 0.9595	47.82 s
	VST+EPLL	34.07 / 0.8892	35.49 / 0.9207	36.94 / 0.9441	38.48 / 0.9604	40.35 / 0.9725	317.13 s
	VST+WNNM	33.94 / 0.8809	35.29 / 0.9126	36.59 / 0.9362	37.84 / 0.9515	39.21 / 0.9621	415.91 s
	PURE-LET	33.50 / 0.8776	34.75 / 0.9066	35.98 / 0.9283	37.16 / 0.9433	38.18 / 0.9505	2.66 s
	DnCNN	34.21 / **0.9029**	35.62 / **0.9311**	**37.07** / **0.9512**	**38.66** / **0.9665**	**40.75** / **0.9791**	**2.39** s
	Noise2Noise	**34.33** / 0.9025	**35.63** / 0.9289	36.92 / 0.9480	38.30 / 0.9625	39.92 / 0.9736	2.58 s
BPAE (Mito)	VST+NLM	35.79 / 0.9279	37.27 / 0.9518	38.93 / 0.9673	40.89 / 0.9781	43.36 / 0.9865	130.14 s
	VST+BM3D	37.43 / 0.9489	38.82 / 0.9632	40.27 / 0.9742	41.80 / 0.9817	43.78 / 0.9879	5.92 s
	VST+KSVD	36.97 / 0.9378	38.49 / 0.9575	39.98 / 0.9712	41.48 / 0.9798	43.33 / 0.9865	241.33 s
	VST+KSVD(D)	36.55 / 0.9305	38.25 / 0.9537	39.89 / 0.9695	41.50 / 0.9792	43.42 / 0.9864	60.91 s
	VST+KSVD(G)	36.93 / 0.9368	38.59 / 0.9579	40.18 / 0.9720	41.71 / 0.9806	43.59 / 0.9871	42.51 s
	VST+EPLL	37.56 / 0.9515	38.95 / 0.9653	40.41 / 0.9757	41.94 / 0.9828	43.98 / 0.9887	312.86 s
	VST+WNNM	37.46 / 0.9486	38.91 / 0.9638	40.34 / 0.9745	41.80 / 0.9816	43.67 / 0.9875	502.87 s
	PURE-LET	36.87 / 0.9433	38.12 / 0.9568	39.47 / 0.9678	40.95 / 0.9764	42.73 / 0.9834	2.70 s
	DnCNN	**37.89** / **0.9586**	**39.30** / **0.9702**	**40.68** / **0.9781**	**42.14** / **0.9841**	**44.00** / **0.9894**	**2.38** s
	Noise2Noise	37.74 / 0.9549	39.13 / 0.9675	40.47 / 0.9756	41.78 / 0.9813	43.22 / 0.9859	2.59 s
Zebrafish Embryo	VST+NLM	28.23 / 0.7895	31.47 / 0.8593	34.00 / 0.9078	35.72 / 0.9328	37.58 / 0.9482	145.64 s
	VST+BM3D	32.00 / 0.8854	33.75 / 0.9102	35.30 / 0.9301	36.78 / 0.9443	38.32 / 0.9546	6.29 s
	VST+KSVD	29.04 / 0.8203	32.17 / 0.8740	34.58 / 0.9167	36.31 / 0.9388	37.86 / 0.9519	60.01 s
	VST+KSVD(D)	28.87 / 0.8184	31.42 / 0.8647	33.97 / 0.9093	35.97 / 0.9350	37.74 / 0.9504	12.54 s
	VST+KSVD(G)	29.03 / 0.8201	31.88 / 0.8701	34.34 / 0.9133	36.26 / 0.9374	38.04 / 0.9520	9.93 s
	VST+EPLL	31.62 / 0.8678	33.66 / 0.9048	35.34 / 0.9298	36.92 / 0.9460	38.61 / 0.9574	317.67 s
	VST+WNNM	30.94 / 0.8654	33.43 / 0.9048	35.23 / 0.9284	36.74 / 0.9432	38.14 / 0.9527	615.40 s
	PURE-LET	30.03 / 0.8019	32.48 / 0.8817	33.84 / 0.8960	35.65 / 0.9254	37.15 / 0.9394	2.59 s
	DnCNN	32.44 / 0.9025	34.16 / 0.9267	**35.75** / **0.9425**	**37.28** / **0.9548**	**39.07** / **0.9659**	**2.44** s
	Noise2Noise	**32.93** / **0.9076**	**34.37** / **0.9270**	35.71 / 0.9410	37.06 / 0.9523	38.65 / 0.9625	2.68 s
Mouse Brain	VST+NLM	36.31 / 0.9534	37.53 / 0.9632	38.95 / 0.9706	40.87 / 0.9763	43.37 / 0.9819	131.08 s
	VST+BM3D	37.95 / 0.9637	39.47 / 0.9704	41.09 / 0.9765	42.73 / 0.9811	44.52 / 0.9847	6.24 s
	VST+KSVD	37.46 / 0.9587	39.24 / 0.9684	40.94 / 0.9757	42.55 / 0.9807	44.24 / 0.9846	85.33 s
	VST+KSVD(D)	36.67 / 0.9544	38.68 / 0.9659	40.63 / 0.9746	42.43 / 0.9804	44.26 / 0.9846	21.95 s
	VST+KSVD(G)	37.30 / 0.9582	39.15 / 0.9681	40.93 / 0.9757	42.65 / 0.9808	44.49 / 0.9849	17.89 s
	VST+EPLL	37.92 / 0.9640	39.50 / 0.9710	41.18 / 0.9772	42.87 / 0.9818	44.73 / 0.9855	320.98 s
	VST+WNNM	37.86 / 0.9624	39.47 / 0.9698	41.08 / 0.9761	42.62 / 0.9804	44.17 / 0.9837	456.09 s
	PURE-LET	36.60 / 0.9359	38.10 / 0.9477	40.06 / 0.9650	41.75 / 0.9739	43.29 / 0.9791	2.54 s
	DnCNN	38.15 / **0.9672**	**39.78** / **0.9741**	**41.41** / **0.9794**	**43.11** / **0.9841**	**45.20** / **0.9887**	**2.35** s
	Noise2Noise	**38.19** / 0.9665	39.77 / 0.9735	41.28 / 0.9787	42.83 / 0.9831	44.56 / 0.9869	2.71 s

Table 2. Denoising performance of confocal microscopy images (the 19-th FOV of each imaging configuration). PSNR (dB), SSIM, and denoising time (seconds) are obtained by averaging over 50 noise realizations through imaging experiments.

Two-Photon Microscopy		Number of raw images for averaging					
Samples	Methods	1	2	4	8	16	Time
BPAE (Nuclei)	VST+NLM	31.34 / 0.9173	32.13 / 0.9286	32.95 / 0.9390	34.14 / 0.9482	37.35 / 0.9571	137.27 s
	VST+BM3D	32.02 / 0.9297	32.70 / 0.9382	33.43 / 0.9458	34.60 / 0.9526	37.77 / 0.9592	5.58 s
	VST+KSVD	31.71 / 0.9227	32.55 / 0.9352	33.37 / 0.9453	34.55 / 0.9535	37.70 / 0.9613	42.51 s
	VST+KSVD(D)	31.48 / 0.9195	32.33 / 0.9323	33.23 / 0.9438	34.48 / 0.9529	37.69 / 0.9612	10.77 s
	VST+KSVD(G)	31.70 / 0.9225	32.52 / 0.9347	33.34 / 0.9448	34.55 / 0.9533	37.75 / 0.9613	8.12 s
	VST+EPLL	32.00 / 0.9313	32.70 / 0.9404	33.48 / 0.9483	34.69 / 0.9552	37.95 / 0.9618	284.32 s
	VST+WNNM	32.01 / 0.9298	32.68 / 0.9383	33.41 / 0.9460	34.55 / 0.9524	37.62 / 0.9585	487.02 s
	PURE-LET	31.62 / 0.9101	32.27 / 0.9198	32.88 / 0.9231	33.97 / 0.9312	36.92 / 0.9439	2.68 s
	DnCNN	31.59 / 0.9250	32.46 / 0.9421	33.38 / **0.9513**	34.75 / **0.9598**	**38.30 / 0.9705**	**2.16** s
	Noise2Noise	**32.44 / 0.9354**	**33.21 / 0.9434**	**34.04** / 0.9509	**35.19** / 0.9590	38.22 / 0.9685	2.51 s
BPAE (F-actin)	VST+NLM	30.26 / 0.7176	31.43 / 0.7799	32.70 / 0.8404	34.24 / 0.8912	37.04 / 0.9297	229.93 s
	VST+BM3D	31.59 / 0.8037	32.52 / 0.8442	33.56 / 0.8813	34.91 / 0.9139	37.56 / 0.9408	5.89 s
	VST+KSVD	30.67 / 0.7381	31.84 / 0.7992	33.10 / 0.8560	34.54 / 0.8995	37.07 / 0.9304	163.48 s
	VST+KSVD(D)	30.43 / 0.7261	31.52 / 0.7833	32.83 / 0.8438	34.38 / 0.8936	37.00 / 0.9279	30.14 s
	VST+KSVD(G)	30.57 / 0.7325	31.69 / 0.7904	32.97 / 0.8485	34.48 / 0.8952	37.09 / 0.9284	24.08 s
	VST+EPLL	31.48 / 0.7950	32.56 / 0.8456	33.72 / 0.8889	35.19 / 0.9237	38.09 / 0.9507	287.27 s
	VST+WNNM	31.24 / 0.7778	32.30 / 0.8278	33.41 / 0.8723	34.76 / 0.9082	37.25 / 0.9345	506.98 s
	PURE-LET	31.19 / 0.7858	32.09 / 0.8267	33.19 / 0.8705	34.53 / 0.9055	36.85 / 0.9295	2.62 s
	DnCNN	31.52 / 0.8222	32.67 / 0.8685	33.92 / **0.9059**	35.47 / **0.9368**	**38.68 / 0.9643**	**2.10** s
	Noise2Noise	**32.00 / 0.8257**	**33.10 / 0.8701**	**34.19** / 0.9048	**35.59** / 0.9342	38.46 / 0.9596	2.32 s
BPAE (Mito)	VST+NLM	35.11 / 0.8525	36.73 / 0.8917	38.66 / 0.9290	40.68 / 0.9554	43.49 / 0.9738	208.28 s
	VST+BM3D	37.52 / 0.9130	38.72 / 0.9338	40.09 / 0.9511	41.62 / 0.9648	43.97 / 0.9766	5.49 s
	VST+KSVD	35.75 / 0.8679	37.34 / 0.9039	39.21 / 0.9367	40.98 / 0.9576	43.29 / 0.9725	97.25 s
	VST+KSVD(D)	35.61 / 0.8648	36.96 / 0.8961	38.77 / 0.9295	40.66 / 0.9536	43.12 / 0.9710	19.32 s
	VST+KSVD(G)	35.74 / 0.8675	37.25 / 0.9019	39.16 / 0.9354	41.07 / 0.9579	43.57 / 0.9737	14.39 s
	VST+EPLL	37.29 / 0.9065	38.81 / 0.9348	40.38 / 0.9549	42.05 / 0.9689	44.58 / 0.9800	291.54 s
	VST+WNNM	36.68 / 0.8929	38.30 / 0.9250	39.90 / 0.9481	41.51 / 0.9636	43.77 / 0.9754	525.45 s
	PURE-LET	36.88 / 0.8946	38.01 / 0.9179	38.70 / 0.9276	40.12 / 0.9459	42.27 / 0.9637	2.77 s
	DnCNN	**38.15 / 0.9251**	**39.46 / 0.9460**	**40.87 / 0.9616**	**42.51 / 0.9738**	**45.32 / 0.9845**	**2.10** s
	Noise2Noise	38.11 / 0.9241	39.38 / 0.9450	40.77 / 0.9606	42.37 / 0.9727	44.82 / 0.9825	2.33 s
Mouse Brain	VST+NLM	32.80 / 0.9134	33.88 / 0.9237	34.88 / 0.9317	36.31 / 0.9384	38.96 / 0.9449	211.65 s
	VST+BM3D	33.81 / 0.9246	34.78 / 0.9317	35.77 / 0.9379	36.97 / 0.9431	39.39 / 0.9481	6.14 s
	VST+KSVD	33.35 / 0.9183	34.47 / 0.9288	35.60 / 0.9374	36.85 / 0.9442	39.27 / 0.9509	79.00 s
	VST+KSVD(D)	32.89 / 0.9147	34.14 / 0.9264	35.43 / 0.9362	36.79 / 0.9437	39.26 / 0.9507	13.64 s
	VST+KSVD(G)	33.34 / 0.9179	34.50 / 0.9285	35.66 / 0.9372	36.94 / 0.9441	39.42 / 0.9508	9.83 s
	VST+EPLL	33.86 / **0.9262**	34.86 / **0.9339**	35.86 / 0.9403	37.11 / 0.9456	39.61 / 0.9506	286.50 s
	VST+WNNM	33.79 / 0.9254	34.75 / 0.9323	35.74 / 0.9386	36.91 / 0.9435	39.22 / 0.9480	512.61 s
	PURE-LET	32.86 / 0.8812	33.47 / 0.8720	34.42 / 0.8769	35.49 / 0.8878	37.40 / 0.8997	2.84 s
	DnCNN	33.67 / 0.9068	34.95 / 0.9290	36.10 / **0.9413**	37.43 / **0.9507**	**40.30 / 0.9630**	**2.30** s
	Noise2Noise	**34.33** / 0.9249	**35.32** / 0.9335	**36.25** / 0.9410	**37.46** / 0.9499	39.89 / 0.9609	2.63 s

Table 3. Denoising performance of two-photon microscopy images (the 19-th FOV of each imaging configuration). PSNR (dB), SSIM, and denoising time (seconds) are obtained by averaging over 50 noise realizations through imaging experiments.

Wide-Field Microscopy		Number of raw images for averaging					
Samples	Methods	1	2	4	8	16	Time
BPAE (Nuclei)	VST+NLM	25.53 / 0.3875	28.49 / 0.5548	31.36 / 0.7122	34.33 / 0.8397	37.74 / 0.9264	138.54 s
	VST+BM3D	26.22 / 0.4339	29.16 / 0.6020	31.99 / 0.7511	34.91 / 0.8650	38.25 / 0.9386	6.13 s
	VST+KSVD	26.38 / 0.4459	29.31 / 0.6132	32.10 / 0.7577	34.99 / 0.8681	38.30 / 0.9397	1348.61 s
	VST+KSVD(D)	26.41 / 0.4489	29.33 / 0.6152	32.11 / 0.7590	35.00 / 0.8688	38.30 / 0.9398	183.82 s
	VST+KSVD(G)	26.40 / 0.4533	29.32 / 0.6182	32.10 / 0.7604	34.98 / 0.8693	38.28 / 0.9399	170.94 s
	VST+EPLL	26.06 / 0.4244	29.00 / 0.5923	31.86 / 0.7440	34.79 / 0.8601	38.15 / 0.9365	354.13 s
	VST+WNNM	26.36 / 0.4440	29.29 / 0.6116	32.11 / 0.7581	35.01 / 0.8690	38.32 / 0.9402	420.74 s
	PURE-LET	26.13 / 0.4258	29.05 / 0.5931	31.89 / 0.7442	34.79 / 0.8593	38.07 / 0.9341	2.49 s
	DnCNN	33.43 / 0.8898	35.56 / 0.9262	37.05 / 0.9437	38.40 / 0.9548	40.12 / 0.9651	**2.48** s
	Noise2Noise	**36.26 / 0.9409**	**37.12 / 0.9462**	**37.88 / 0.9508**	**38.80 / 0.9569**	**40.33 / 0.9660**	2.64 s
BPAE (F-actin)	VST+NLM	23.93 / 0.3370	27.02 / 0.4988	30.21 / 0.6672	33.58 / 0.8096	37.67 / 0.9150	132.00 s
	VST+BM3D	24.72 / 0.3792	27.84 / 0.5467	31.02 / 0.7084	34.36 / 0.8367	38.27 / 0.9258	5.66 s
	VST+KSVD	24.94 / 0.3910	28.03 / 0.5575	31.22 / 0.7178	34.54 / 0.8426	38.48 / -0.9292	1343.88 s
	VST+KSVD(D)	25.01 / 0.3965	28.11 / 0.5629	31.28 / 0.7213	34.59 / 0.8445	38.51 / 0.9297	175.55 s
	VST+KSVD(G)	25.04 / 0.4036	28.13 / 0.5683	31.30 / 0.7245	34.60 / 0.8458	38.50 / 0.9299	156.79 s
	VST+EPLL	24.55 / 0.3711	27.70 / 0.5393	30.88 / 0.7018	34.24 / 0.8331	38.16 / 0.9241	352.19 s
	VST+WNNM	24.94 / 0.3900	28.01 / 0.5560	31.17 / 0.7154	34.48 / 0.8406	38.36 / 0.9272	438.09 s
	PURE-LET	24.67 / 0.3736	27.75 / 0.5393	30.90 / 0.7012	34.18 / 0.8306	37.64 / 0.9134	2.49 s
	DnCNN	32.54 / 0.8050	34.27 / 0.8486	35.78 / 0.8817	37.47 / 0.9133	39.62 / 0.9436	**2.06** s
	Noise2Noise	**33.30 / 0.8264**	**34.67 / 0.8590**	**36.03 / 0.8869**	**37.65 / 0.9162**	**39.75 / 0.9452**	2.66 s
BPAE (Mito)	VST+NLM	26.26 / 0.4134	29.35 / 0.5850	32.55 / 0.7418	35.96 / 0.8610	39.93 / 0.9389	134.42 s
	VST+BM3D	26.93 / 0.4611	30.03 / 0.6312	33.24 / 0.7778	36.65 / 0.8831	40.58 / 0.9487	5.97 s
	VST+KSVD	27.11 / 0.4737	30.20 / 0.6417	33.38 / 0.7845	36.76 / 0.8863	40.70 / 0.9504	1247.01 s
	VST+KSVD(D)	27.14 / 0.4768	30.22 / 0.6440	33.40 / 0.7859	36.78 / 0.8869	40.69 / 0.9504	172.92 s
	VST+KSVD(G)	27.13 / 0.4804	30.22 / 0.6464	33.40 / 0.7870	36.76 / 0.8872	40.66 / 0.9503	161.30 s
	VST+EPLL	26.80 / 0.4524	29.91 / 0.6233	33.12 / 0.7721	36.51 / 0.8791	40.46 / 0.9471	345.91 s
	VST+WNNM	27.08 / 0.4709	30.17 / 0.6400	33.37 / 0.7841	36.77 / 0.8866	40.69 / 0.9502	430.37 s
	PURE-LET	26.85 / 0.4528	29.94 / 0.6231	33.13 / 0.7709	36.49 / 0.8777	40.27 / 0.9440	2.56 s
	DnCNN	34.87 / 0.8965	36.90 / 0.9228	38.75 / 0.9405	40.65 / 0.9552	42.78 / 0.9684	**2.18** s
	Noise2Noise	**35.55 / 0.9105**	**37.30 / 0.9288**	**39.08 / 0.9436**	**40.88 / 0.9567**	**42.91 / 0.9692**	2.71 s

Table 4. Denoising performance of wide-field microscopy images (the 19-th FOV of each imaging configuration). PSNR (dB), SSIM, and denoising time (seconds) are obtained by averaging over 50 noise realizations through imaging experiments.