

Title: Supplementary Movie 1.

Description: Volumetric imaging of visually evoked calcium signaling of GCaMP7s⁺ dendrites and dendritic spines in the awake mouse V1 *in vivo* by Bessel focus scanning without and with AO. Imaging volume: $128 \times 128 \times 60 \mu\text{m}^3$ from $Z = 340 \mu\text{m}$ to $Z = 400 \mu\text{m}$ below pia. Visual stimuli: 12 full-field drifting gratings (0° to 330° at 30° increments) in pseudorandom sequences. Ten trials were repeated for each stimulus and the trial-averaged results were presented in the movie.

Title: Supplementary Movie 2.

Description: Imaging of visually evoked calcium signaling of GCaMP7s⁺ dendrites and dendritic spines in the awake mouse V1 *in vivo* from a single optical section ($Z = 350 \mu\text{m}$ below pia) by Gaussian focus scanning without and with AO. Visual stimuli: 12 full-field drifting gratings (0° to 330° at 30° increments) in pseudorandom sequences. Ten trials were repeated for each stimulus and the trial-averaged results were presented in the movie.

Title: Supplementary Movie 3.

Description: Spontaneous calcium transients of GCaMP6s⁺ dendrites and dendritic spines in a volume ($128 \times 100 \times 60 \mu\text{m}^3$ from $Z = 190 \mu\text{m}$ to $Z = 250 \mu\text{m}$ below pia) imaged by Bessel focus scanning without and with AO at 2 Hz volume rate.

Title: Supplementary Movie 4.

Description: Spontaneous calcium transients of GCaMP6s⁺ dendrites and dendritic spines at a single optical section ($128 \times 100 \mu\text{m}^2$ at $Z = 220 \mu\text{m}$ below pia) imaged by Gaussian focus scanning without and with AO at 3.3 Hz frame rate.

Title: Supplementary Movie 5.

Description: Volumetric imaging of visually evoked glutamate signaling (iGluSnFR-A184S) in apical dendritic spines of a visual cortical neuron in an awake mouse *in vivo* by Bessel focus scanning without and with AO ($128 \times 128 \times 60 \mu\text{m}^3$ from $Z = 60 \mu\text{m}$ to $Z = 120 \mu\text{m}$ below pia). Visual stimuli: 12 full-field drifting gratings (0° to 330° at 30° increments) in pseudorandom sequences. Twenty trials were repeated for each stimulus and the trial-averaged results were presented in the movie.

Title: Supplementary Movie 6.

Description: Volumetric imaging of visually evoked glutamate signaling (iGluSnFR-A184S) in basal dendritic spines of a visual cortical neuron in an awake mouse *in vivo* by Bessel focus scanning without and with AO ($128 \times 128 \times 60 \mu\text{m}^3$ from $Z = 120 \mu\text{m}$ to $Z = 180 \mu\text{m}$ below pia). Visual stimuli: 12 full-field drifting gratings (0° to 330° at 30° increments) in pseudorandom sequences. Twenty trials were repeated for each stimulus and the trial-averaged results were presented in the movie.

Title: Supplementary Software.

Description: MATLAB® codes used to generate the AO-corrected Bessel phase patterns and to calculate PSF for foci experiencing non-circularly-symmetric aberrations are included in Supplementary Software.