Electronic Supplementary Information

Deep-tissue NIR-II bioimaging performance of Si-based and InGaAs-based imaging devices using short-wave infrared persistent luminescence

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Brief summary − This file contains nine supplemental figures, including: transmission electron microscopy image, intensities of SWIR PersL signals traversing chick tissues, decay of $MgGeO_3:Yb^{3+}$ ceramic and nanoparticles, extended SWIR imaging through chicken tissue, SWIR imaging through 5 mm chicken tissue with an exposure time of 2 s, IVIS imaging of feces of mice, SWIR imaging of gastrointestinal tract of a mouse, and IVIS imaging of lungs and livers of mice.

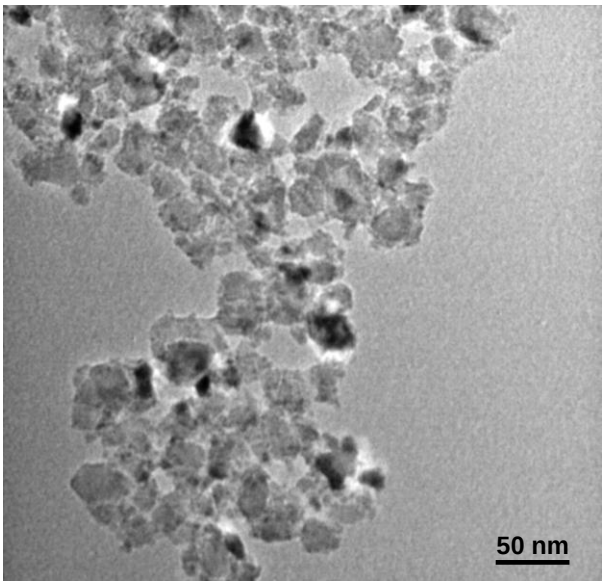
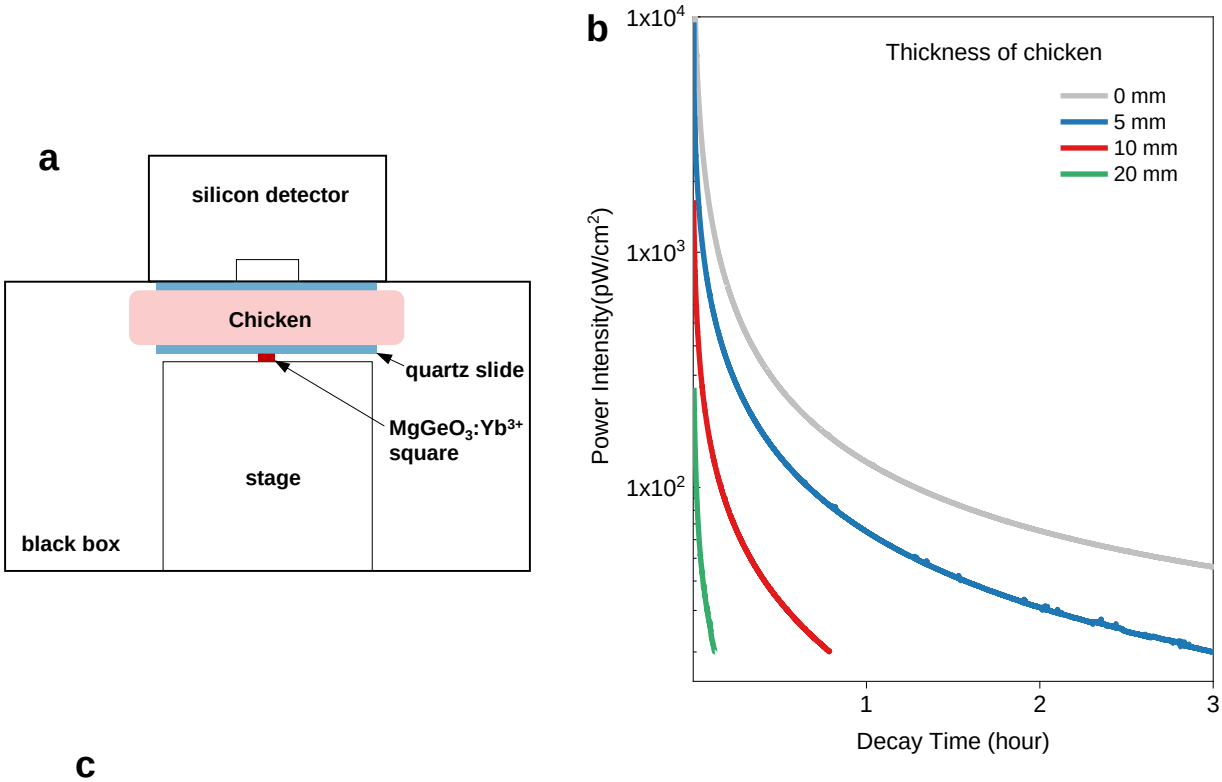


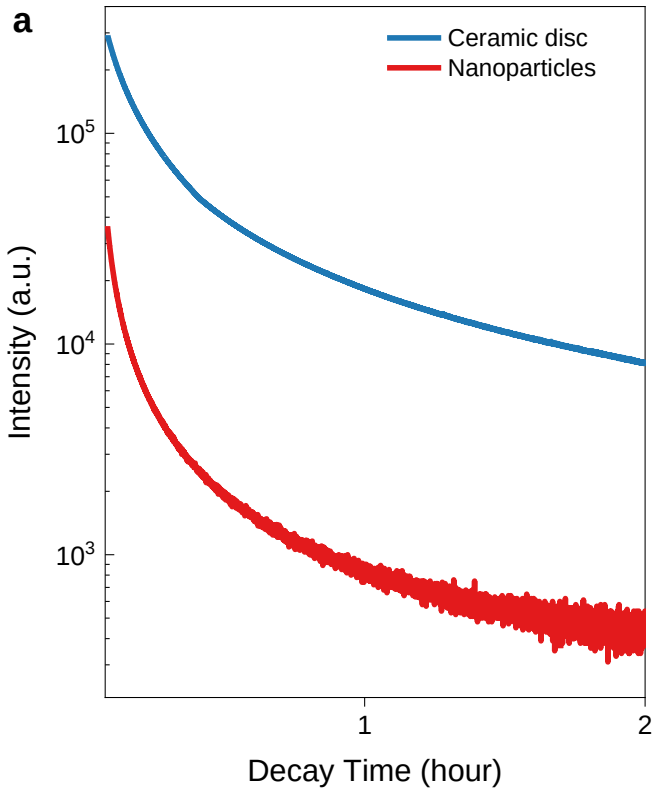
Figure S1 Transmission electron microscopy image of $MgGeO_3:Yb^{3+}$ nanoparticles. The sizes of the nanoparticles are in the range of 20–50 nm.



c

Thickness of chicken	Power (pW/cm^2)		
	1 min	5 min	10 min
0 mm	8016	1771	862
5 mm	2489	748	386
10 mm	617	178	96
20 mm	110	29	N/A

Figure S2 Power intensity of SWIR PersL of a $MgGeO_3:Yb^{3+}$ ceramic square (3 mm × 3 mm) passing through 5–20 mm chicken breast tissues. (a) Measurement setup. A $MgGeO_3:Yb^{3+}$ ceramic square was placed under a quartz slide. After irradiated by a 254 nm UV lamp for 2 min, the square was covered by a chicken breast piece with a thickness of 5 mm, 10 mm, or 20 mm. Another quartz slide was then placed on the top of chicken breast. The entire assembly was enclosed within a small black box with a hole (12 mm diameter) on the top. The SWIR PersL signals passing through the chicken breast was collected and recorded by a Newport 918D-SL-OD3R silicon detector (with a sensor size of 11.3 mm) and a Newport 2936-R optical power and energy meter. The minimum detectable power of this system was 20 pW. The measured wavelength was centered at 973 nm. As a comparison, the power intensity of the ceramic square without covering chicken tissue (i.e., 0 mm) was also measured. (b) Plots of measured power intensities through 0–20 mm chicken *versus* decay time. (c) Power intensities at 1 min, 5 min and 10 min decay time points.



b

Decay Time	Normalized Intensity		Intensity Ratio (Nanoparticles/Ceramic)
	Ceramic	Nanoparticles	
5 min	8.1	1.0	0.123
10 min	3.9	0.25	0.064
30 min	1.1	0.053	0.048
60 min	0.50	0.023	0.046
120 min	0.22	0.012	0.055

Figure S3 PersL decay curves of $MgGeO_3:Yb^{3+}$ ceramic disc and nanoparticles. The samples were irradiated by a 254 nm UV lamp for 2 min. The measurements started at 5 min after the cease of the irradiation. The monitoring wavelength was 973 nm. (a) Decay curves. (b) Normalized PersL emission intensities at some decay time points (5, 10, 30, 60, 120 min) and the intensity ratios of nanoparticles to ceramic.

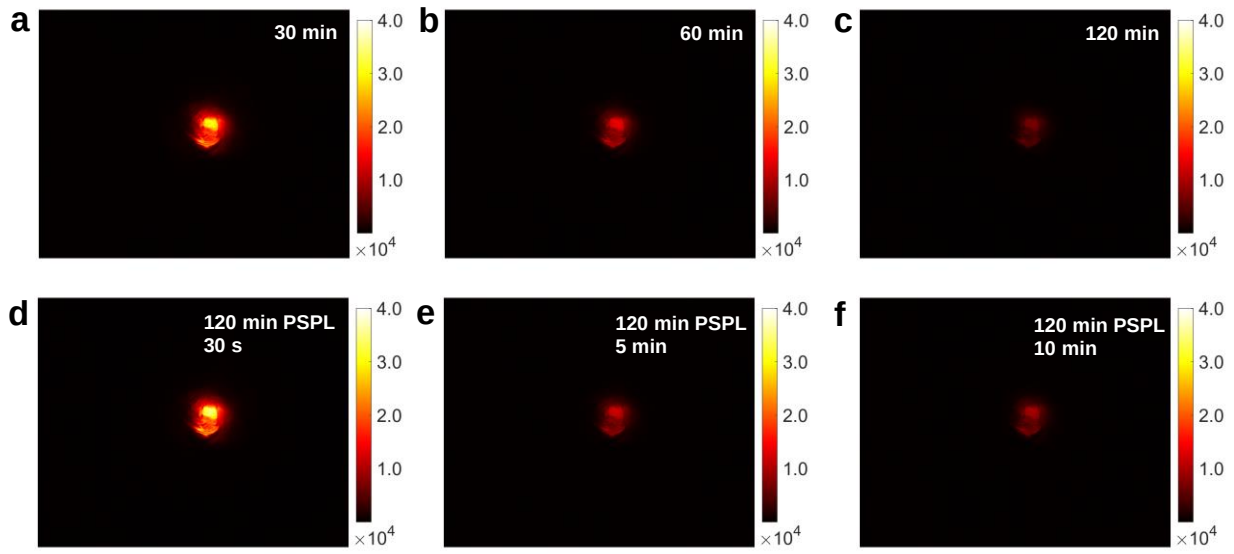


Figure S4 Extended imaging of SWIR PersL signals from a $MgGeO_3:Yb^{3+}$ ceramic square (3 mm × 3 mm) through 5 mm chicken breast tissue using a SWIR imaging system. (a–c) Images of SWIR PersL signals acquired at 30 min, 60 min and 120 min decays. These images are the extended imaging of Fig. 2j–l in the main text. The ceramic square was pre-irradiated by a 254 nm UV lamp for 2 min. (d–f) Images of SWIR PSPL signals. The 120 min decayed ceramic square in (c) was illuminated by a 900-lumen white LED flashlight through the 5 mm chicken for 30 s, and the PSPL signals were acquired at 30 s, 5 min, and 10 min after the illumination. The exposure times for all images were 10 s. The unit for the radiance was p/s.

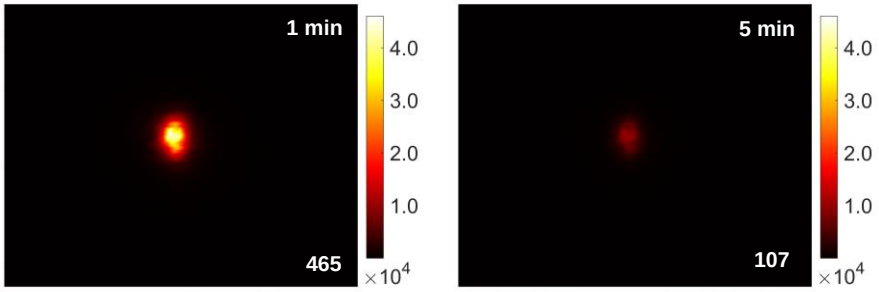


Figure S5 Imaging the SWIR PersL signals from a UV pre-charged $MgGeO_3:Yb^{3+}$ ceramic square (3 mm × 3 mm) through 5 mm chicken breast tissue. The SWIR PersL signals were acquired at 1 min and 5 min decay. The exposure time was 2 s. The unit for the radiance was p/s. The value at the bottom right corner of each image is the SBR.

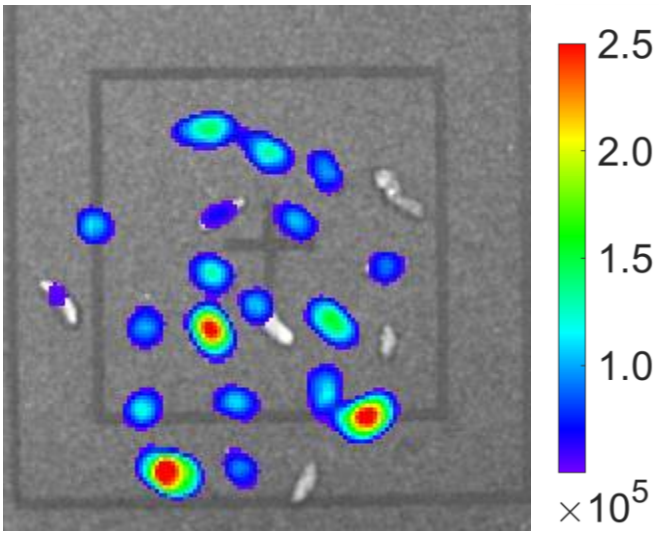


Figure S6 IVIS image of feces. The feces were collected within 24 h after oral administration of 2 mg $MgGeO_3$:Yb^{3+} nanoparticles (see Fig. 4a–f in the main text). The feces were irradiated by a 254 nm UV lamp for 2 min. The image was taken on an IVIS imager with an exposure time of 10 s. The unit for the radiance was p/s/cm^2/sr.

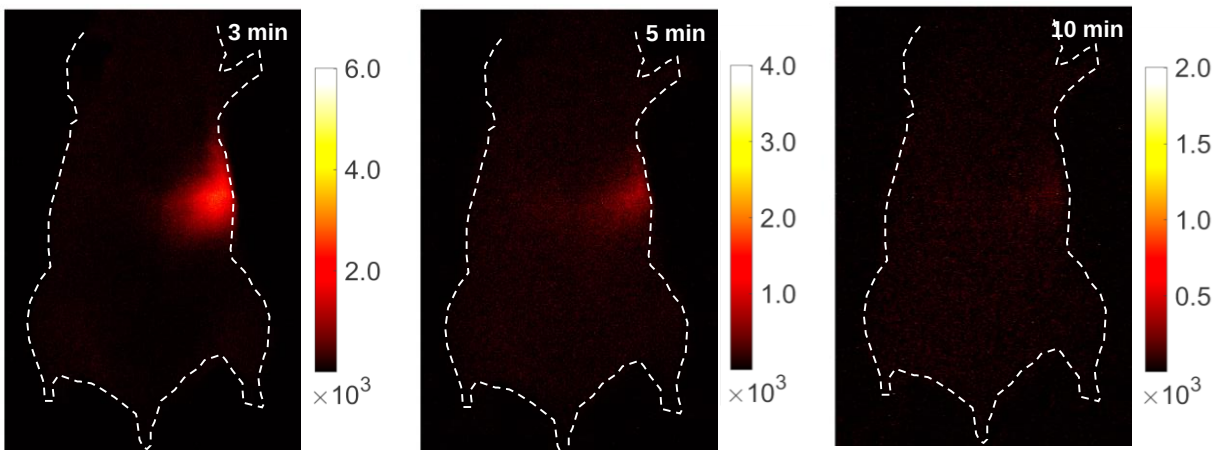


Figure S7 In vivo imaging of $MgGeO_3:Yb^{3+}$ nanoparticles in the gastrointestinal tract of nude mice using a SWIR imaging system. 2 mg (200 μL, 10 mg mL^{-1}) of UV pre-charged (254 nm lamp for 2 min) nanoparticles was oral administrated into the stomach of a mouse. The SWIR PersL signals were acquired at 3 min, 5 min and 10 min after the administration. The exposure time for the SWIR imaging was 30 s. The unit for the radiance was p/s.

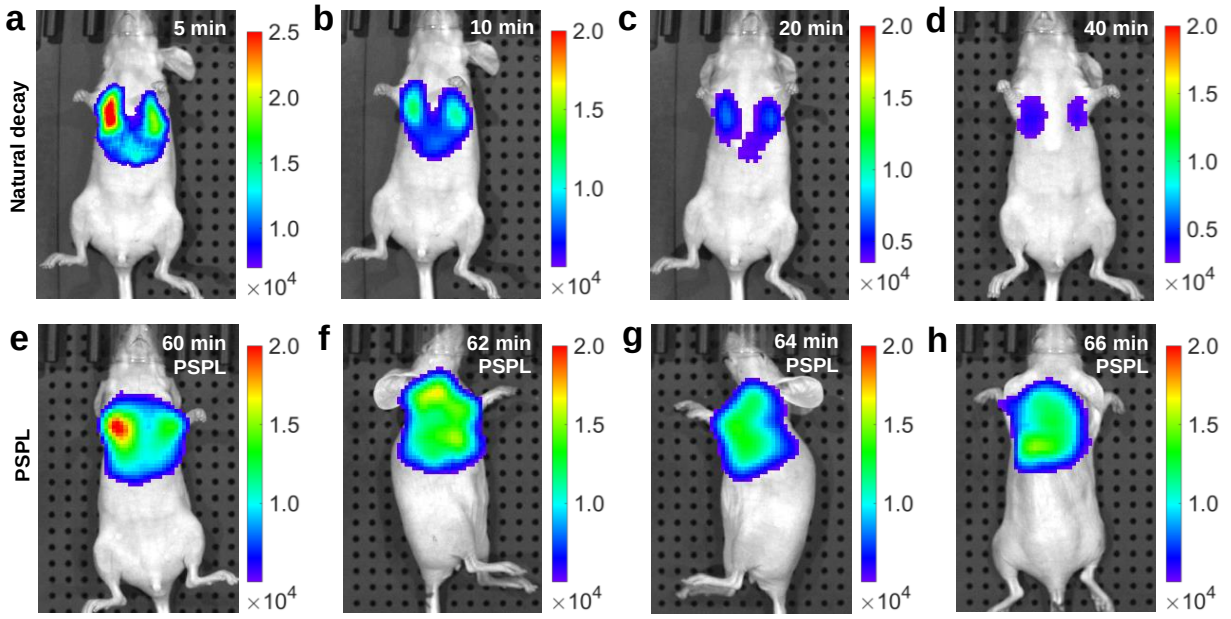


Figure S8 Tracking the distribution of $MgGeO_3:Yb^{3+}$ nanoparticles using an IVIS imaging system after intravenous injection of 50 μg nanoparticles. (a–d) Images of SWIR PersL signals acquired at 5 min, 10 min, 20 min and 40 min after tail vein injection of 50 μg (50 μL, 1 mg mL^{-1}) of UV pre-irradiated (254 nm lamp for 2 min) nanoparticles. (e–h) Images of SWIR PSPL signals after 60 min p.i. The mouse was irradiated by a white LED flashlight (for 30 s) and then imaged in the ventral view (e), left lateral view (f), right lateral view (g), and dorsal view (h). For all images, the exposure times were 10 s. The unit for the radiance was $p/s/cm^2/sr$.

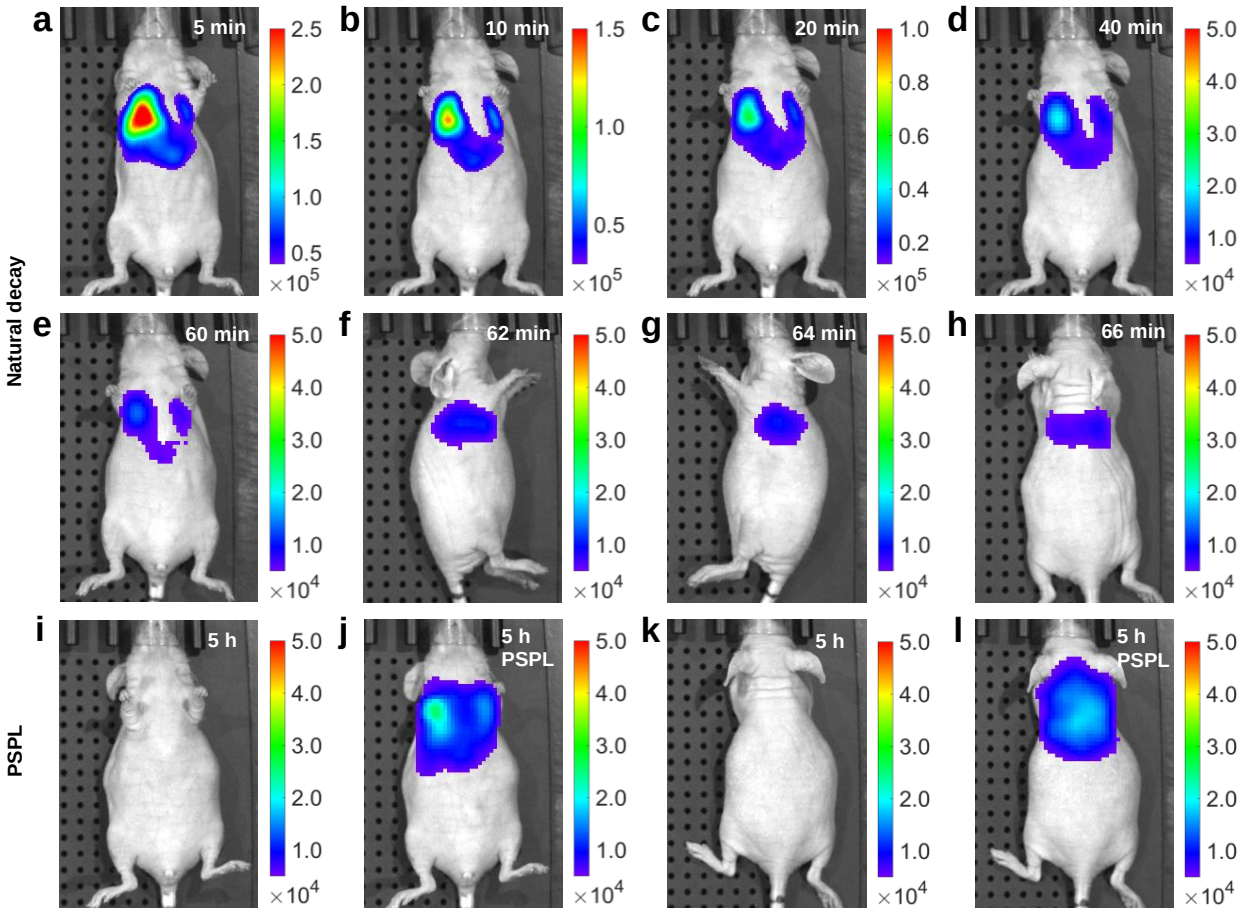


Figure S9 Tracking the distribution of $MgGeO_3:Yb^{3+}$ nanoparticles using an IVIS imaging system after intravenous injection of 200 μg nanoparticles. (a–e) Images of SWIR afterglow signals acquired at 5 min, 10 min, 20 min, 40 min, and 60 min after tail vein injection of 200 μg (100 μL, 2 mg mL^{-1}) of UV pre-irradiated (254 nm lamp for 2 min) nanoparticles. The mouse was imaged in ventral view. (f–h) IVIS images taken in left lateral view (f) at 62 min p.i., right lateral view (g) at 64 min p.i., and dorsal view (h) at 66 min p.i. (i,j) Ventral view images acquired before and after illuminating the mouse by a 900 lumen white LED flashlight (for 30 s) at 5 h p.i. (k,l) Dorsal view images acquired before and after illuminating the mouse by a 900 lumen white LED flashlight (for 30 s) at 5 h p.i. For all images, the exposure times were 10 s. The unit for the radiance was $p/s/cm^2/sr$.