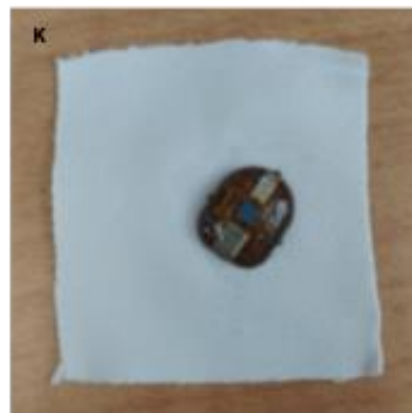
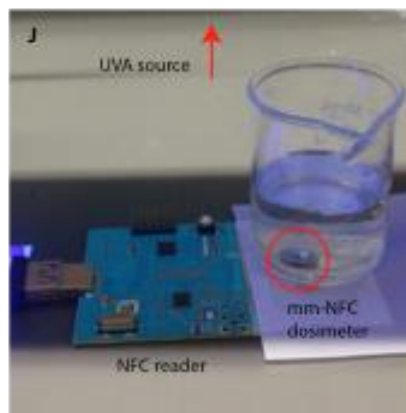
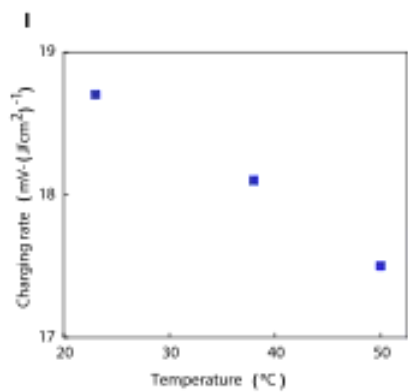
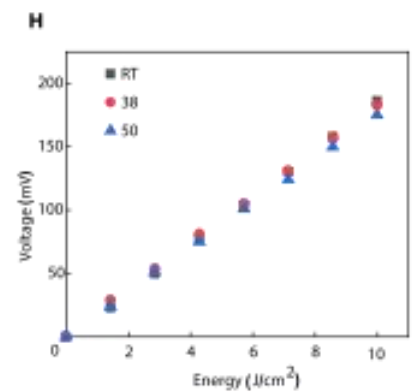
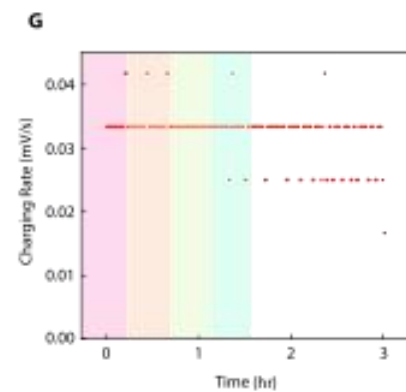
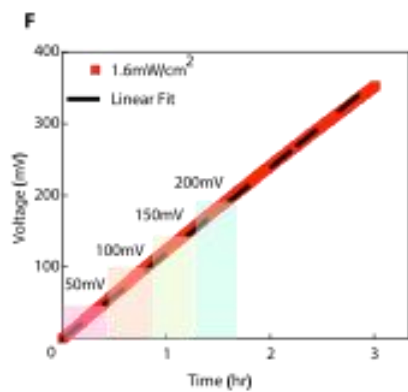
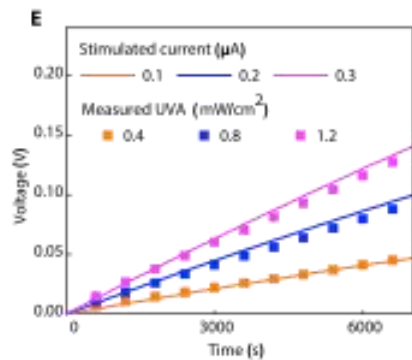
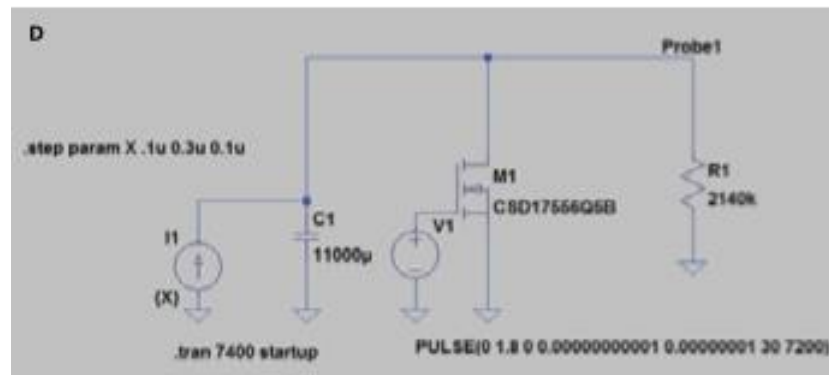
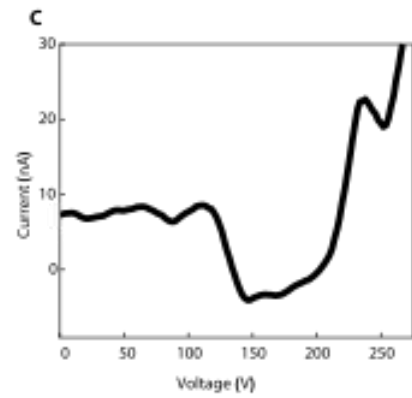
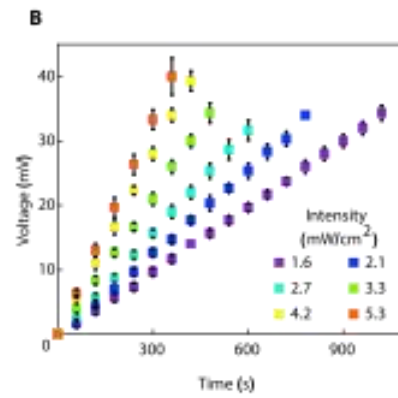
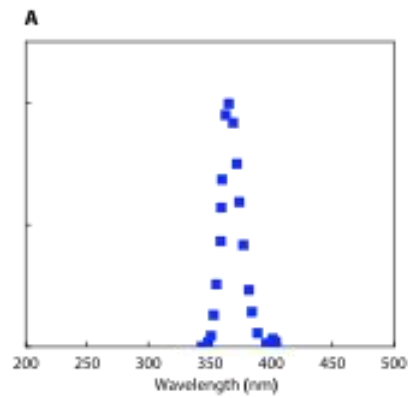


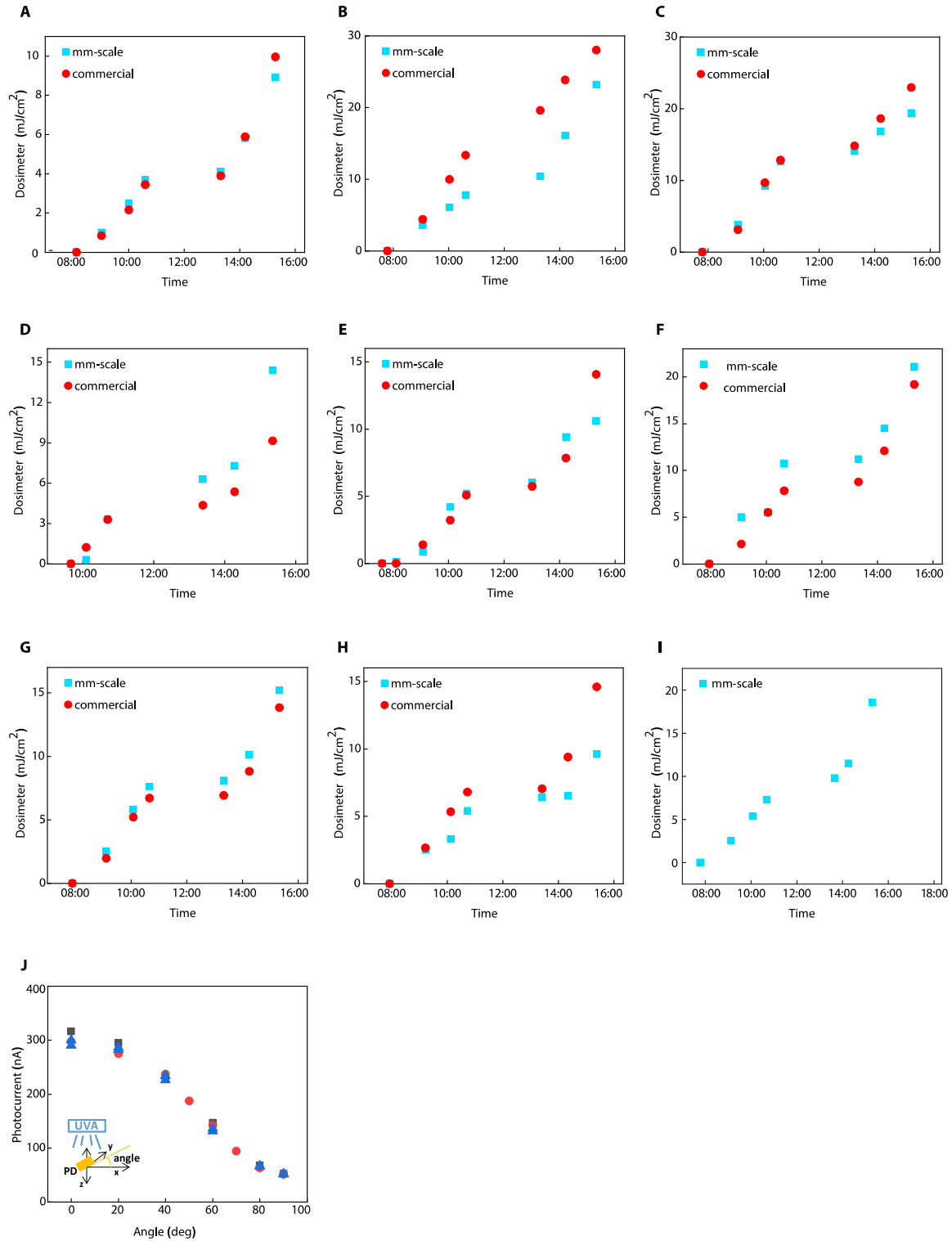
**Fig. S1. Screenshots of the smart phone application.** Wirelessly coupling a millimeter-scale, battery-free dosimeter to an NFC-enabled smartphone activates the device and the NFC communication link, resulting in a display of the measurement result on the screen of the smartphone. The app also features a reset command that activates the MOSFET to discharge the supercapacitor, thereby resetting the device.



**Fig. S2. Millimeter-scale, battery-free wireless sensors of UVA/UVB radiation.** (A) Photographic images of mm-NFC UVA/UVB dosimeter as a skin patch mounted on shoulder, (B) mm-NFC UVA/UVB dosimeter as a shoe clip, (C) mm-NFC UVA/UVB dosimeter as a hair clip, (D) mm-NFC UVA dosimeter as a button, and (E) mm-NFC UVA dosimeter integrated into a hat.

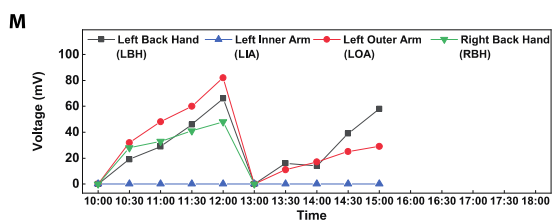
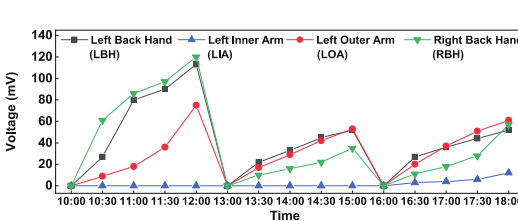
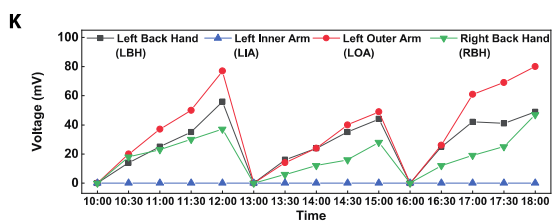
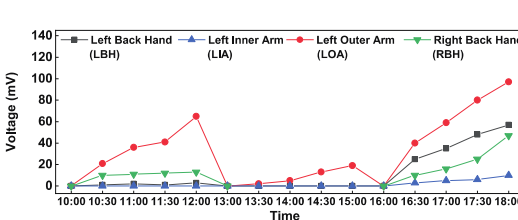
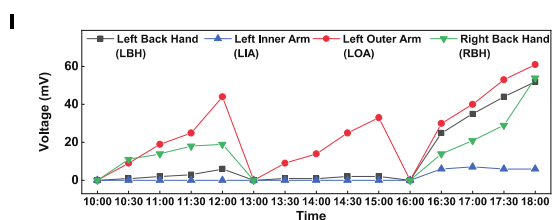
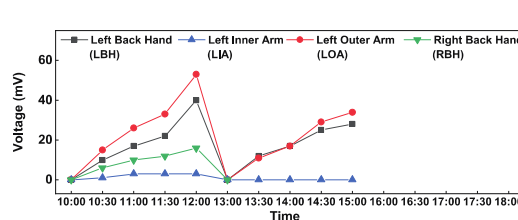
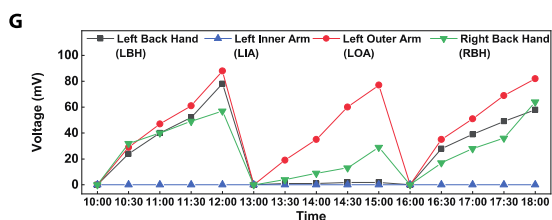
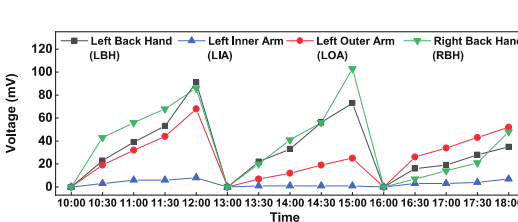
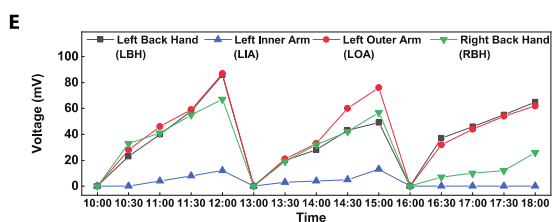
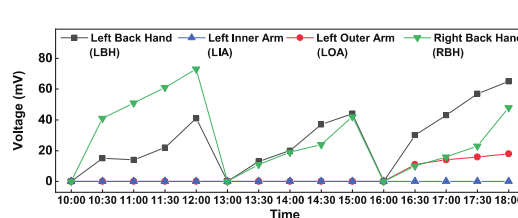
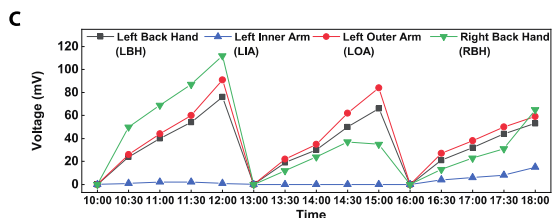
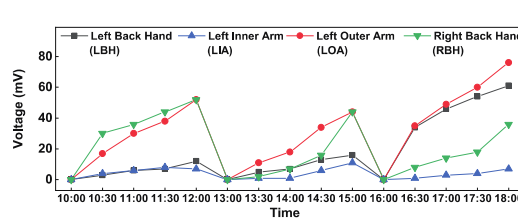
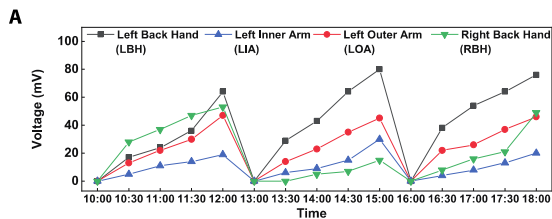


**Fig. S3. Electrical characterization and simulation.** (A) Spectral response of narrowband UVA lamp with peak at 365 nm (UVL-16, Analytik Jena). (B) Voltage output as a function of time of UVA exposure measured with mm-NFC UVA dosimeters (n=3). UVA lamp exposed dosimeters with constant intensity at six different intensities across a range from low to very high UVA index conditions outdoors. The error bars represent the standard deviation. (C) Current versus voltage response of analog to digital converter (ADC) of the NFC system-on-a-chip (n=1) in the OFF state (no RF field applied), indicating leakage current to ground. (D) Schematic for the SPICE simulation of the circuit, where R1 represents a linear leakage current pathway. (E) Comparison of simulated and measured output voltages for the circuit. (F) Voltage response of mm-NFC UVA dosimeter (n=1) with constant exposure over 3 hours. Readouts were wirelessly obtained every 10 minutes. (G) Derivative plot of voltage response in (E). (H) Voltage output of mm-NFC UVA (n=1) as a function of cumulative energy measured at room temperature, 38°C, and at 50°C. (I) Respective charging rate of mm-NFC UVA (n=1) as a function of temperature under constant exposure conditions. (J) Experimental setup of a mm-NFC UVA dosimeter submerged in heated water. The dosimeter was exposed to constant intensity of UVA as heated water cooled from 50°C to room temperature. Voltage and temperature readouts were obtained every 5 minutes with a reader antenna (not in contact with water). (K) Photograph of mm-NFC UVA dosimeter on a fabric swatch after an accelerated stress test in the washing machine.



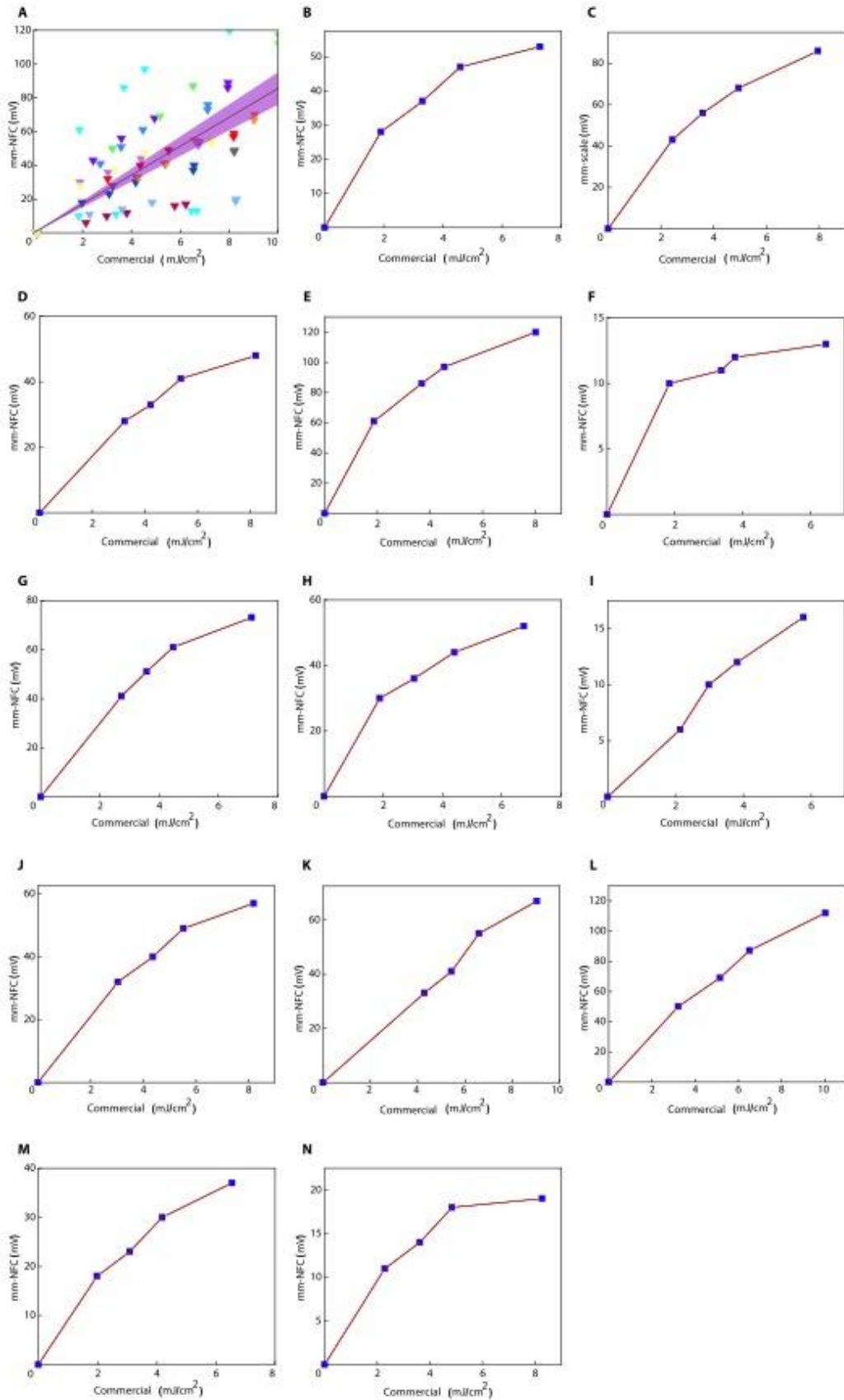
**Fig. S4. Field study results involving human subjects outdoors in Rio, Brazil. (A-I)** Comparison of mm-NFC UVA dosimeter measurements to those of a standard commercial dosimeter from Scienterra. The measurements are from subjects (n=9) in Rio, Brazil on the 10th

of March of 2016. Commercial dosimeter from one subject failed. Subjects wore one mm-NFC UVA dosimeter on the thumbnail or the middle fingernail, and one commercial dosimeter on the right wrist. Subjects engaged in preferred recreational activity of choice on a roof top. The voltage output of mm-NFC UVA dosimeters are scaled by a factor of 1000. One commercial dosimeter (I) failed during experiment. (J) Photocurrent from three UVA photodiodes as a function of orientation of photodiodes around y-axis with respect to UVA exposure source at constant orientation and intensity.

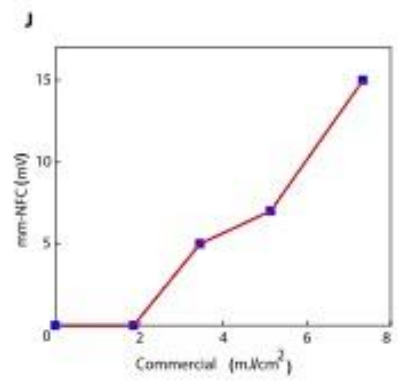
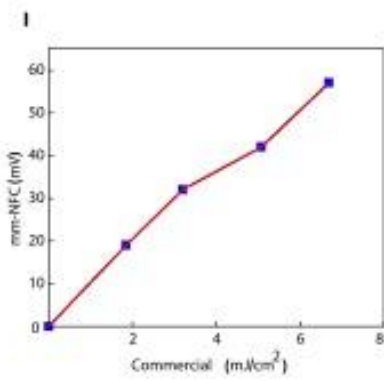
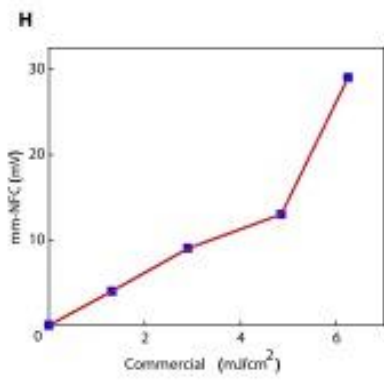
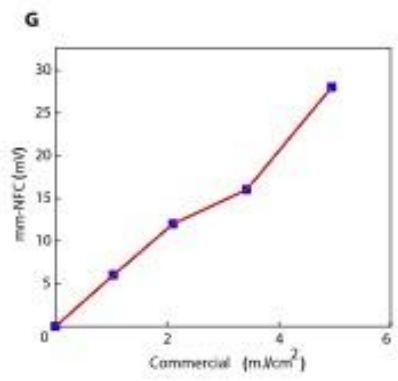
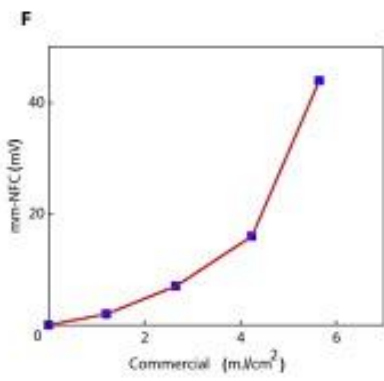
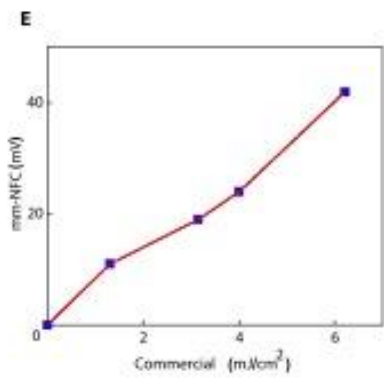
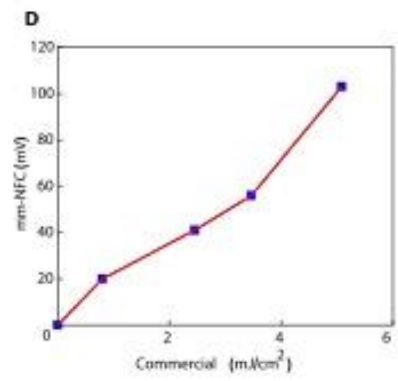
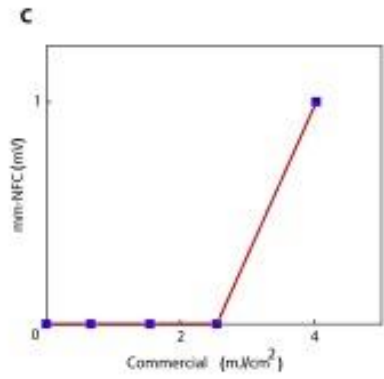
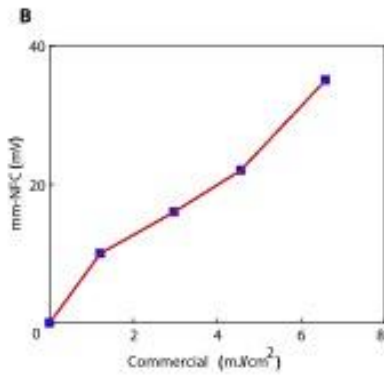
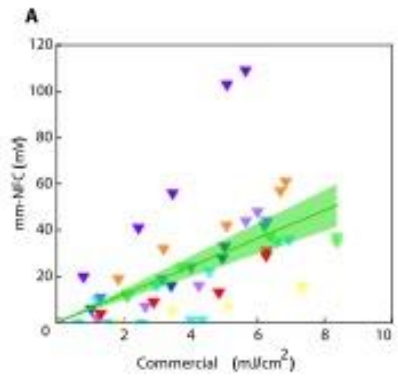


**Fig. S5. Field study results from outdoor exercise involving human subjects in St. Petersburg, FL. (A-M)** Individual level subjection data collected during an outdoor morning, afternoon and evening exercise sessions using mm-NFC dosimeters to those obtained with a commercial dosimeter. The measurements are from 13 study subjects in St. Petersburg, Florida on the August of 2016. Subjects wore mm-UVA NFC dosimeter patches on the right back hand (RBH), left back hand (LBH), left outer arm (LOA) and left inner arm (LIA). Four devices from RBH failed during an afternoon exercises. Measurements were acquired after walking north, east, west and south for approximately 30 minutes.

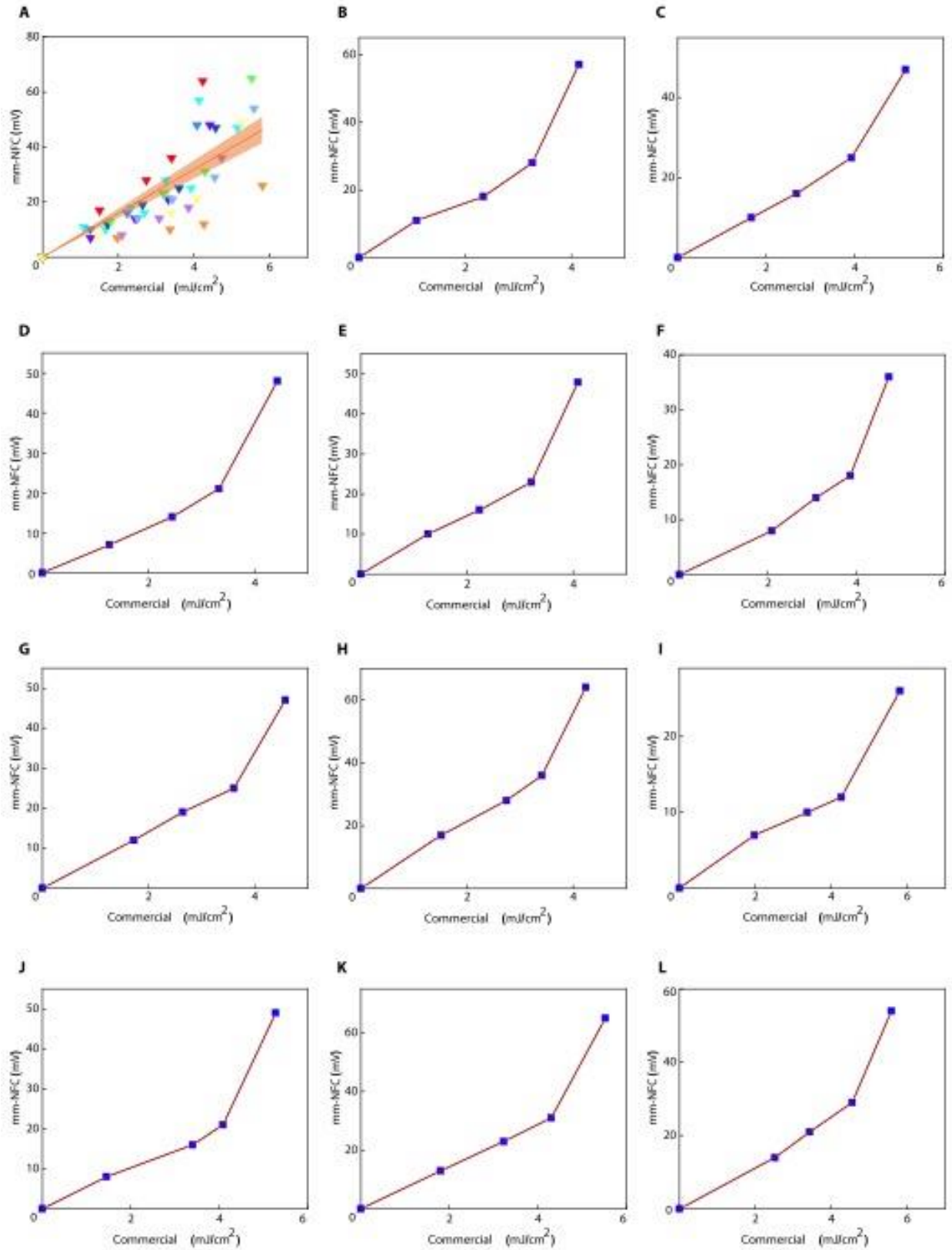




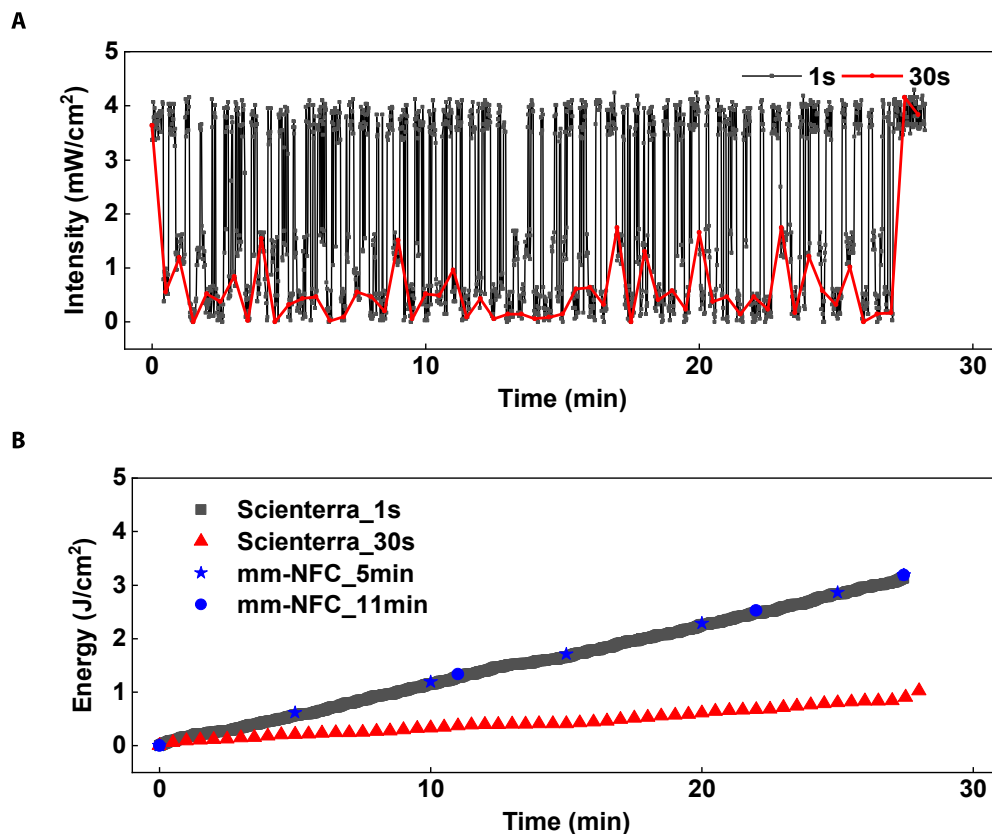
**Fig. S6. Field study results from a morning exercise involving human subjects in St. Petersburg, FL.** (A) Comparison of measurements collected during an outdoor morning exercise using mm-NFC dosimeters to those obtained with a commercial dosimeter. The measurements are from 13 study subjects in St. Petersburg, Florida on the August of 2016. Subjects wore mm-UVA NFC dosimeter patch on the right back hand and a commercial dosimeter on the ipsilateral wrist. Measurements were acquired after walking north, east, west and south for approximately 30 minutes. The graph includes a linear fit and a 95% confidence interval (shading). (B-N) Comparison of measurements collected during an outdoor morning exercise for individual subjects.



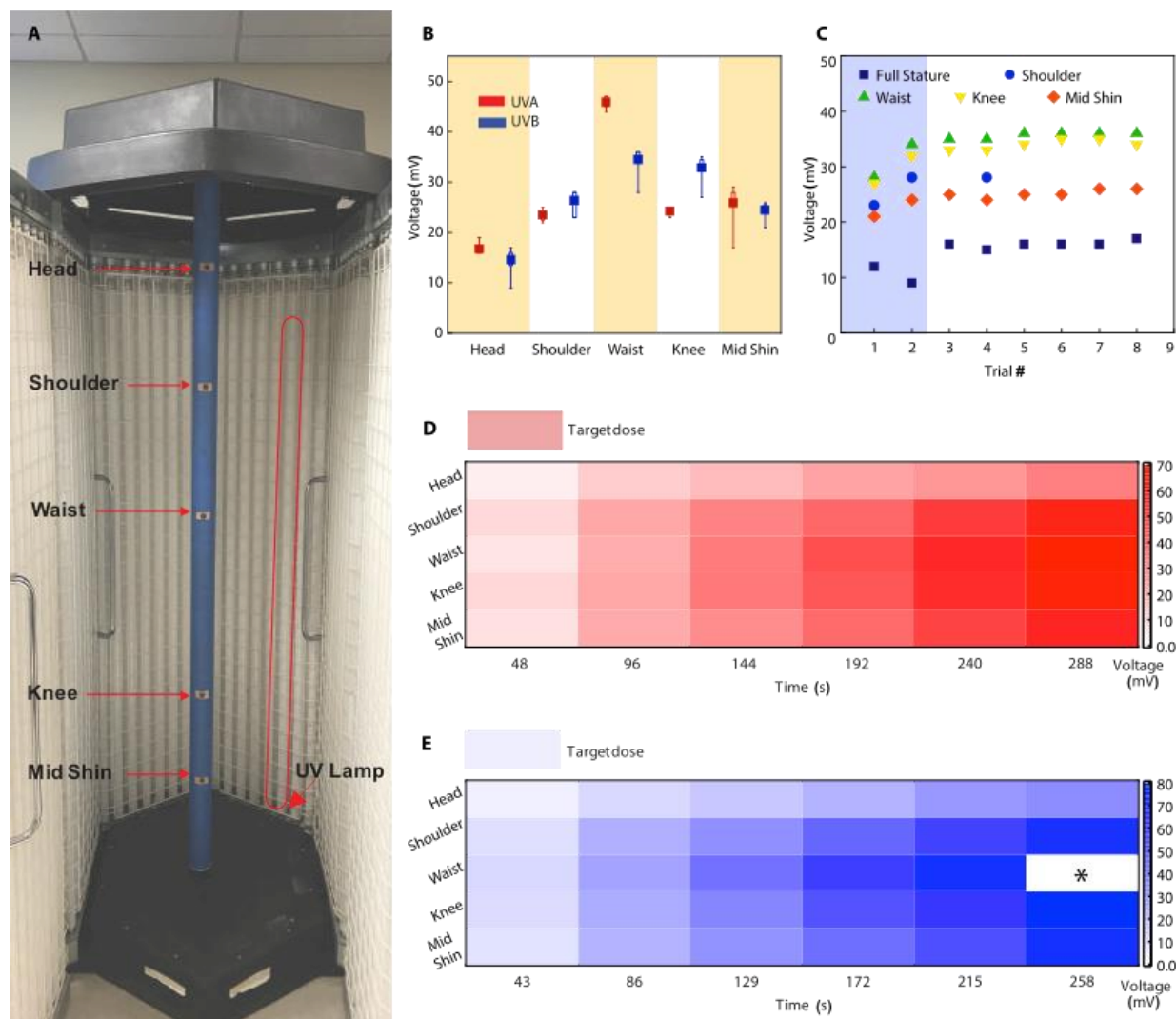
**Fig. S7. Field study results from an afternoon exercise involving human subjects in St. Petersburg, FL.** (A) Comparison of measurements collected during an outdoor afternoon exercise using mm-NFC dosimeters to those obtained with a commercial dosimeter. The measurements are from 9 study subjects in St. Petersburg, Florida on the August of 2016. Subjects wore mm-UVA NFC dosimeter patch on the right back hand and a commercial dosimeter on the ipsilateral wrist. Four devices failed during testing (data not shown). Measurements were acquired after walking north, east, west and south for approximately 30 minutes. The graph includes a linear fit and a 95% confidence interval (shading). (B-J) Comparison of measurements collected during an outdoor afternoon exercise for individual subjects.



**Fig. S8. Field study results from an evening exercise involving human subjects in St. Petersburg, FL. (A)** Comparison of measurements collected during an outdoor evening exercise using mm-NFC dosimeters to those obtained with a commercial dosimeter. The measurements are from 11 study subjects in St. Petersburg, Florida on the August of 2016. Subjects wore mm-UVA NFC dosimeter patch on the right back hand and a commercial dosimeter on the ipsilateral wrist. Measurements are acquired after walking north, east, west and south for approximately 30 minutes. The graph includes a linear fit and a 95% confidence interval (shading). **(B-L)** Comparison of measurements collected during an outdoor evening exercise for individual subject.



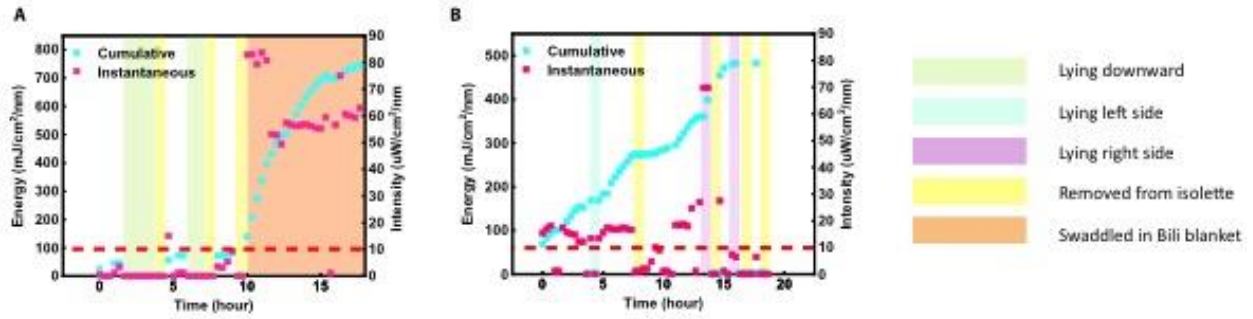
**Fig. S9. UVA dosimetry measurements performed with Scienterra and an mm-NFC UVA device, during time-dependent simulated shading (A)** UVA (395 nm) exposure intensity as a function of time measured by the Scienterra sensor ( $n=1$ ) operating with sampling intervals of 1 s and 30 s. Simulations involved absorbing films moved into and out of the light path between a UVA lamp and the devices, to simulate time depending shading. **(B)** Scienterra measurements of cumulative exposure dose computed by temporal integration of intensities over time sampled at 1 s (black) and 30 s (red), and corresponding results from mm-NFC UVA ( $n=1$ ) measurements of cumulative dose recorded every 5 min (blue; star) and 11 min (blue; circle).



**Fig. S10. Demonstrations of the use of mm-NFC dosimeters with dual operation in the UVA and UVB spectrums in a clinical phototherapy unit.** (A) Experimental setup of five dosimeters positioned along a vertical axis, corresponding to different anatomical locations, inside a UVB phototherapy unit. The sensor locations correspond to the average height of the head, shoulder, waist, knee and mid shin. (B) Box-and-whisker plot with minimum, maximum, 25%, 75% percentile, and mean of NFC dosimeter measurements (n=8) from devices after phototherapy exposure to 21 mW/cm<sup>2</sup> of UVA (360 nm) for 238 s and to 4.6 mW/cm<sup>2</sup> UVB (311nm) for 118 s. During UVB phototherapy session, the device at the shoulder failed (shoulder UVB; n=3) (C) UVB dosimetry results from devices at five different height after UVB phototherapy (n=8) under constant exposure conditions. The initial 2 trials highlight the warm-up phase of the UVB lamps. During UVB phototherapy session, the device at the shoulder failed (shoulder UVB; n=3) (D) Color map of UVA dosimetry results from devices at five different heights after the UVA phototherapy. The reported results are means of 5 trials. (E) Color map of UVB dosimetry results from devices at five different heights after the UVB phototherapy. The results are means of 5 trials. One device failed (\*).







**Fig. S11. Clinical utility of blue light mm-NFC dosimeters in a neonatal intensive care unit.** (A, B) Measurements of instantaneous intensity and cumulative dosimetry from mm-NFC blue light dosimeters mounted on the chests of three different jaundiced infants throughout the course of a 20 h phototherapy sessions. Shading indicates position or status of the neonate inside the incubator.

**Table S1. mm-NFC dosimeters with dual operation in the UVA and UVB spectrums after UVA phototherapy in clinical phototherapy unit.** Experimental setup of five dosimeters positioned along a vertical axis, corresponding to different anatomical locations, inside a UVA phototherapy unit. The sensor locations correspond to the average height of the head, shoulder, waist, knee and mid shin. NFC dosimeter measurements (n=8) from devices after phototherapy exposure to 21 mW/cm<sup>2</sup> of UVA (360 nm) for 238 s.

Anatomical locations	Heights (in)	Measured UVA exposure (mV)							
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Full Stature	66.5	16	16	16	17	17	16	17	19
Shoulder	54.3	22	22	23	24	24	25	24	24
Waist	41.1	44	44	46	47	47	46	46	47
Knee	21	23	24	25	25	24	25	24	24
Mid shin	10	25	26	26	28	17	28	29	28

**Table S2. mm-NFC dosimeters with dual operation in the UVA and UVB spectrums after UVB phototherapy in clinical phototherapy unit.** Experimental setup of five dosimeters positioned along a vertical axis, corresponding to different anatomical locations, inside a UVB phototherapy unit. The sensor locations correspond to the average height of the head, shoulder, waist, knee and mid shin. NFC dosimeter measurements (n=8) from devices after phototherapy exposure to 4.6 mW/cm<sup>2</sup> UVB (311nm) for 118 s. During UVB phototherapy session, the device at the shoulder failed (x).

Anatomical locations	Heights (in)	Measured UVB exposure (mV)							
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Full Stature	66.5	12	9	16	15	16	16	16	17
Shoulder	54.3	23	28	x	28	x	x	x	x
Waist	41.1	28	34	35	35	36	36	36	36
Knee	21	27	32	33	33	34	35	35	34
Mid shin	10	21	24	25	24	25	25	26	26

**Table S3. Spatial-temporal measurement of clinical UVA phototherapy unit measured with mm-NFC dosimeters with dual operation in the UVA and UVB spectrums.** Experimental setup of five dosimeters positioned along a vertical axis, corresponding to different anatomical locations, inside a UVA phototherapy unit. The sensor locations correspond to the average height of the head, shoulder, waist, knee and mid shin. NFC dosimeter measurements (n=5) from devices after phototherapy exposure to 21 mW/cm<sup>2</sup> of UVA (360 nm) over time.

		UVA phototherapy time (s)																													
		48					96					144					191					239					287				
Trial #		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Measured UVA exposure (mV)	Full stature	5	3	7	5	6	18	11	12	16	13	17	22	17	21	20	24	25	25	23	28	30	29	28	31	27	34	34	31	34	34
	Shoulder	8	9	13	10	8	27	22	21	27	21	32	33	32	37	34	43	44	47	42	41	53	52	50	55	51	64	65	64	62	62
	Waist	5	8	6	7	6	21	22	24	22	23	37	37	35	39	34	48	49	50	46	47	61	57	55	60	57	69	73	67	72	69
	Knee	9	12	9	11	12	25	22	22	26	23	36	41	33	41	35	48	45	49	46	44	59	58	52	59	59	68	72	66	69	65
	Mid shin	6	9	8	12	7	24	22	21	27	23	27	30	32	35	31	41	38	40	40	39	50	52	44	53	49	58	63	57	62	58

**Table S4. Spatial-temporal map of clinical UVB phototherapy unit measured with mm-NFC dosimeters with dual operation in the UVA and UVB spectrums.** Experimental setup of five dosimeters positioned along a vertical axis, corresponding to different anatomical locations, inside a UVB phototherapy unit. The sensor locations correspond to the average height of the head, shoulder, waist, knee and mid shin. NFC dosimeter measurements (n=5) from devices after phototherapy exposure to 4.6 mW/cm<sup>2</sup> UVB (311nm) over time. During UVB phototherapy session, the device at the waist failed (x).

		UVB phototherapy time (s)																													
		43					87					130					174					217					261				
Trial #		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Measured UVB exposure (mV)	Full stature	4	5	5	6	6	12	14	12	9	11	19	18	18	20	17	25	25	24	25	23	36	33	29	31	29	38	35	37	35	34
	Shoulder	7	11	10	11	11	24	26	24	23	26	36	34	37	37	33	47	47	50	48	48	59	63	56	61	55	76	67	75	70	68
	Waist	9	12	13	14	14	28	32	29	29	29	45	44	47	44	42	63	60	62	58	61	71	77	69	71	x	76	x	x	x	x
	Knee	9	11	12	11	12	23	30	24	25	26	40	35	42	37	35	55	49	55	49	56	59	70	57	69	57	83	67	82	83	77
	Mid shin	8	9	10	10	10	23	26	24	19	26	32	36	35	32	32	46	41	49	43	48	53	57	51	62	54	75	59	73	72	71