

Supporting Information to
**Nanoparticle ultrastructure allows reversible pH sensitivity using ^{19}F NMR and
in vivo ^{19}F MRI**

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NPs	Size (nm)	PDI
Gd multi-core	200 ± 20	0.2
Gd single-core	160 ± 10	0.15
Control	200 ± 25	0.2

Table S1. Average size and PDI of NPs measured by DLS. Data are presented for three types of NPs: Gd multi-core, Gd single-core, and control. The values represent the average diameter (nm) and PDI, based on measurements from 9, 4, and 5 batches, respectively, used in this study.

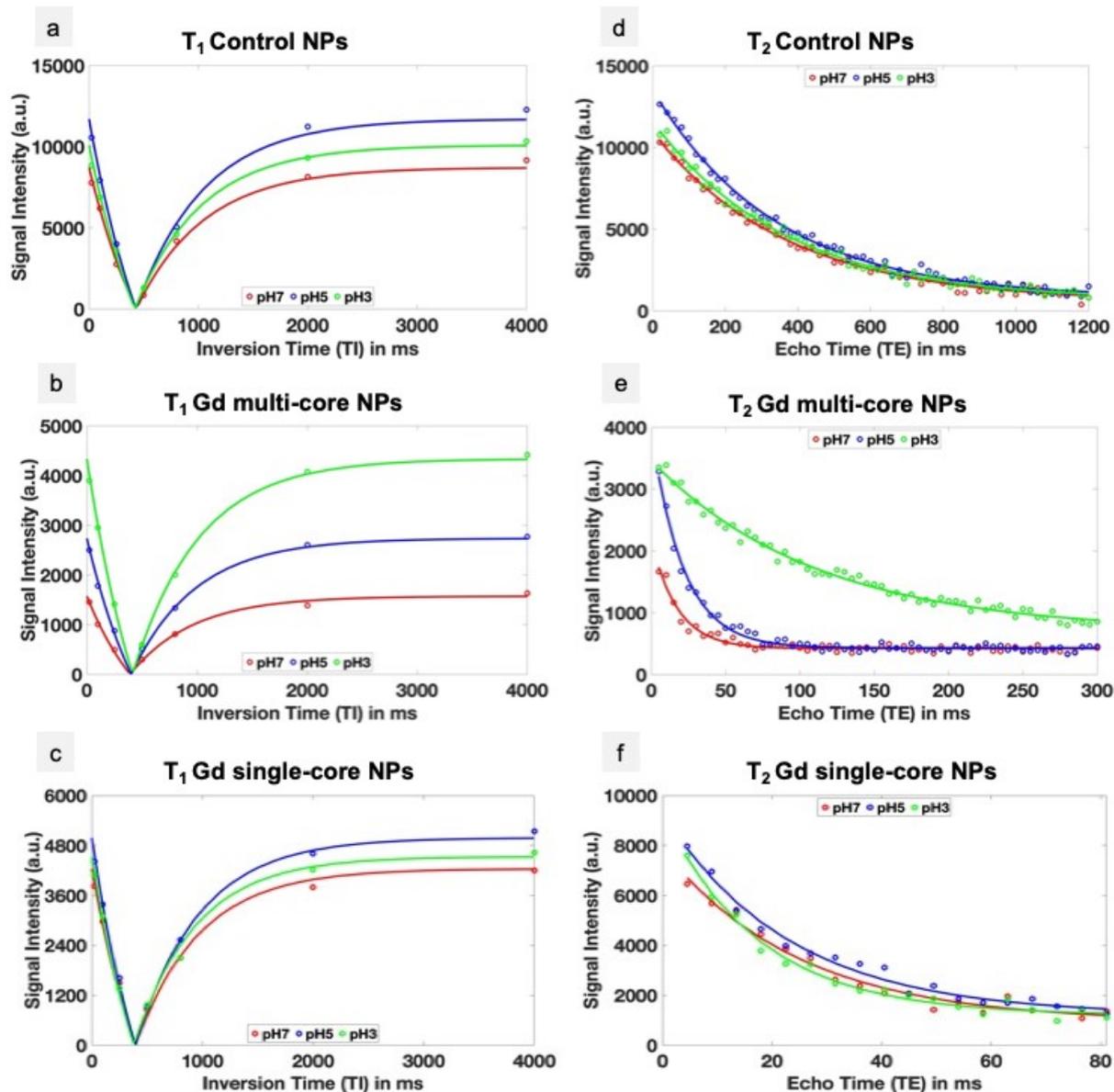


Figure S1. ^{19}F MR T_1 and T_2 relaxation times curves measured at 14 T for control (a,d), Gd multi-core (b,e) and Gd Single-core (c,f) NPs.

pH	$^1\text{H } T_1$ (ms)
7	1248
5	1260
3	1080
H ₂ O	1672

Table S2. $^1\text{H } T_1$ relaxation times (ms) measured by 14 T MR for Gd multi-core NPs at pH 7, 5, and 3. Water was used as a reference.

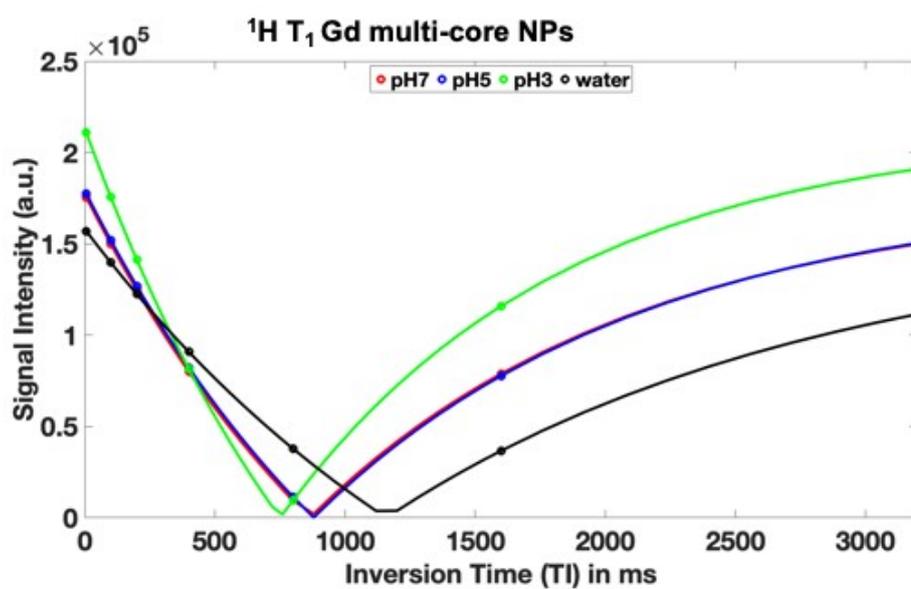


Figure S2. $^1\text{H } T_1$ curve measured at 14 T MR for Gd multi-core NPs at pH 7, 5, and 3. Water was used as the control

pH	Solvent	Size (nm)	PDI
7	D ₂ O	228 ± 0.5	0.1
3	Formic Acid	230 ± 0.5	0.1
3	Acetic Acid	231 ± 2.5	0.06
3	HCl	229 ± 1.5	0.07

Table S3. DLS measurements (diameter and PDI) of Gd multi-core NPs after ¹⁹F NMR analysis. The NPs were resuspended in deuterium oxide (D₂O) as a control (pH 7) and in various organic acids (pH 3): formic acid, acetic acid, chloridric acid (HCl).

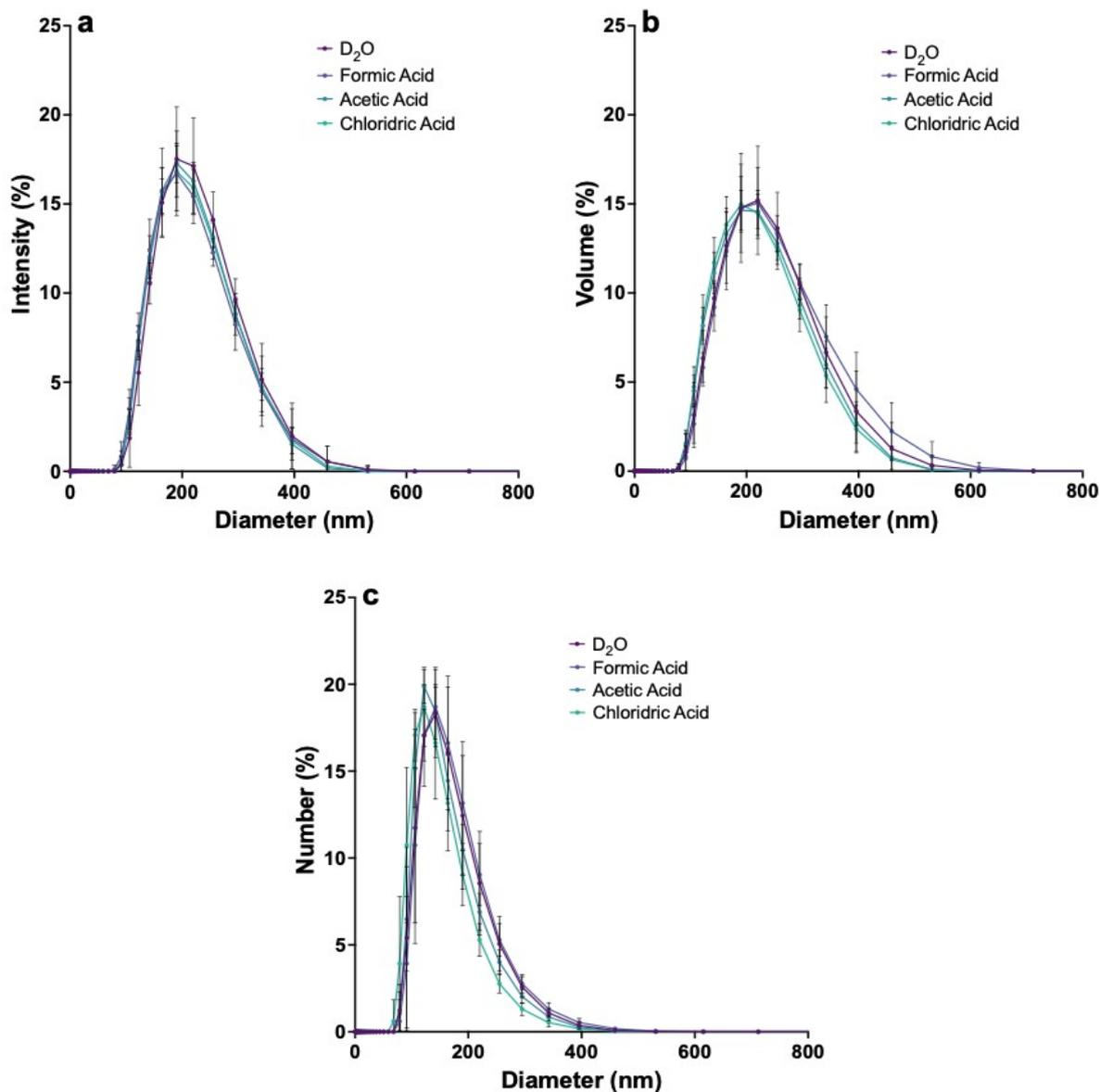


Figure S3. Size distribution of Gd multi-core NPs after ¹⁹F NMR analysis, presented as (a) intensity, (b) volume, and (c) number. The NPs were resuspended in various organic acids (formic acid, acetic acid, hydrochloric acid and deuterium oxide (D₂O)) as a control. The graphs represent the average of four independent measurements, including standard deviations.

pH	Size (nm)	PDI
3	194 ± 4	0.06
7	192 ± 2	0.06
7 from pH 3	194 ± 3	0.07

Table S4. DLS measurements (diameter and PDI) of Gd multi-core NPs after the ¹⁹F NMR reversibility experiment. Three samples from the same batch were analysed: one resuspended at pH 3, one at pH 7, and another that was initially resuspended at pH 3 and then neutralized to pH 7 using 5N NaOH.

pH	T ₂ (Batch_1)	T ₂ (Batch_2)
3	24	17
7	162	189
7 from pH 3	28	15

Table S5. Additional batches for reversibility experiments. ¹⁹F T₂ relaxation times measured for two independently prepared Gd multi-core nanoparticle batches (Batch 1 and Batch 2) resuspended at pH 7, pH 3 (HCl solution), and after neutralization back to pH 7 (“7 from pH 3”) using 5 N NaOH. All measurements were performed by ¹⁹F NMR at 500 MHz under identical experimental conditions, with a nanoparticle concentration of 6.5 mg/mL.

pH	^{19}F T_2 (ms)
7	15
3	160
7 from pH 3	18

Table S6. ^{19}F T_2 values of Gd multi-core NPs resuspended in acetic acid at pH 7, pH 3, and initially at pH 3 and then neutralized to pH 7 using 5N NaOH. Measurements were performed using ^{19}F NMR at 500 MHz.

Control NPs	$^{19}\text{F } T_2$ (ms)
Overnight uptake	759
Premixing	780
NPs	750

Gd Multi-core NPs	$^{19}\text{F } T_2$ (ms)
Overnight uptake	208
Premixing	30
NPs	28

Table S7: $^{19}\text{F } T_2$ values of Gd multi-core NPs and control NPs at time 0 (premixing), after 12 hours (overnight uptake), and for NPs alone. Measurements were performed at 37°C using ^{19}F NMR at 500 MHz.

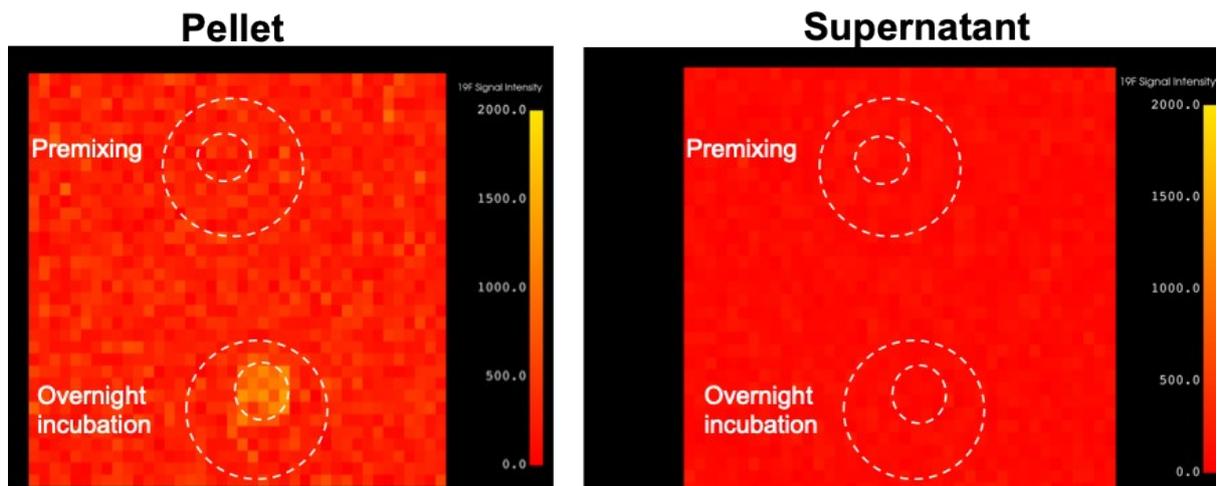


Figure S4: ¹⁹F MR images (14T) of the RAW 264.7 cells pellet and supernatant after premixing and overnight incubation with Gd multi-core NPs without thresholding.

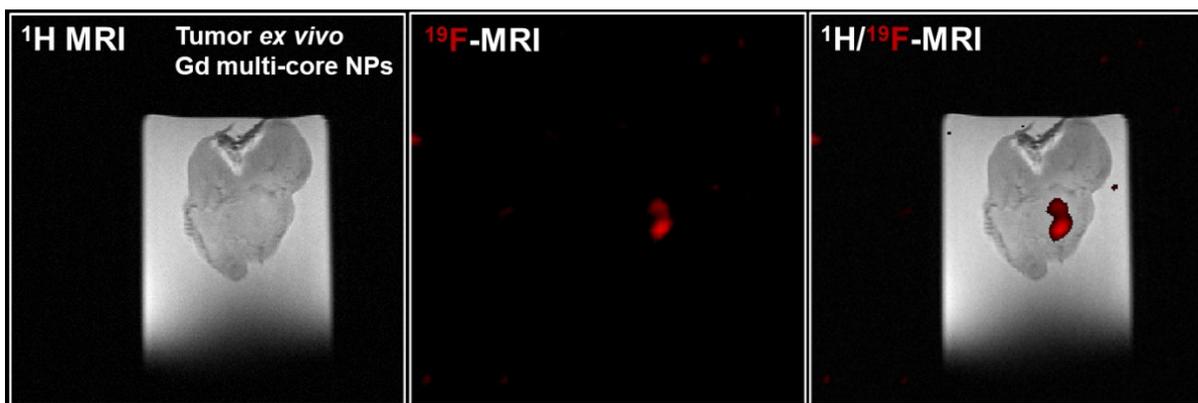


Figure S5. ^1H and ^{19}F MR images (7T) of the tumour *ex vivo*. The ^{19}F MR signal confirm the Gd multi-core NPs (IT injection) responsiveness in lower pH of the tumor microenvironment.