Electronic Supplementary Material (ESI) for Faraday Discussions.

Supplementary Information

Highly luminescent gold nanoparticles: effect of ruthenium distance for nanoprobes with enhanced lifetimes

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Table S1: Dynamic light scattering sizing data of AuNP in water.

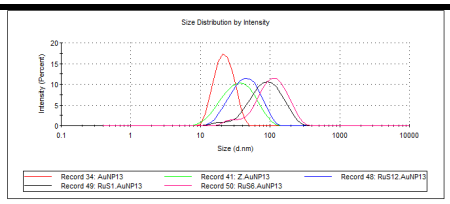
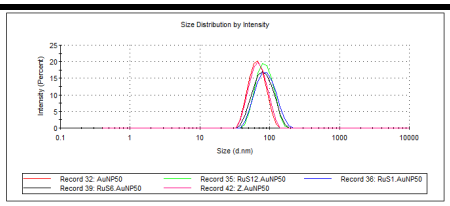
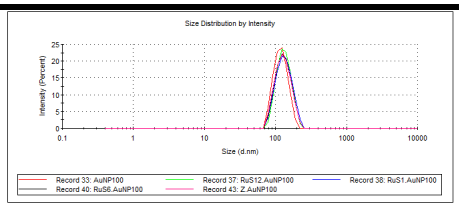
	Number distribution / nm	Intensity distribution / nm	PDI	Intensity distribution graphs
AuNP13	14 ± 4	23 ± 7	0.09	
Z·AuNP13	12 ± 4	40 ± 20	0.19	
RuS1·AuNP13	15 ± 6	96 ± 50	0.26	
RuS6·AuNP13	24 ± 9	116 ± 57	0.26	
RuS12·AuNP13	18 ± 6	48 ± 22	0.14	
AuNP50	50 ± 12	68 ± 18	0.04	
Z·AuNP50	50 ± 12	70 ± 19	0.04	
RuS1·AuNP50	59 ± 17	90 ± 27	0.09	
RuS6·AuNP50	54 ± 15	84 ± 26	0.08	
RuS12·AuNP50	61 ± 16	86 ± 24	0.04	
AuNP100	101 ± 24	120 ± 26	0.01	
Z·AuNP100	107 ± 27	130 ± 35	0.02	
RuS1·AuNP100	109 ± 28	134 ± 33	0.03	
RuS6·AuNP100	107 ± 27	131 ± 31	0.03	
RuS12·AuNP100	112 ± 27	133 ± 30	0.02	

Table S2: Zeta potential data of AuNP in water.

	ζ-potential / mV		ζ-potential / mV		ζ-potential / mV
AuNP13	(-) 46 ± 16	**AuNP50**	(-) 31 ± 13	**AuNP100**	(-) 38 ± 12
Z·AuNP13	(-)50 ± 8	**Z·AuNP50**	(-)62 ± 18	**Z·AuNP100**	(-) 53 ± 11
RuS1·AuNP13	(-) 49 ± 11	**RuS1·AuNP50**	(-) 31 ± 10	**RuS1·AuNP100**	(-) 47 ± 10
RuS6·AuNP13	(-) 62 ± 15	**RuS6·AuNP50**	(-) 44 ± 16	**RuS6·AuNP100**	(-) 26 ± 9
RuS12·AuNP13	(-) 42 ± 13	**RuS12·AuNP50**	(-) 42 ± 12	**RuS12·AuNP100**	(-) 36 ± 10

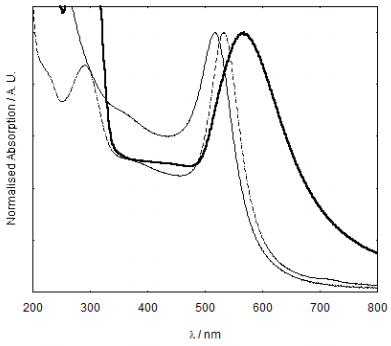


Figure S1: UV-Vis of the citrate stabilised AuNP13 (thin solid line), AuNP50 (dotted line) and AuNP100 (thick solid line) in water. The spectra are taken from 200 – 800 nm.

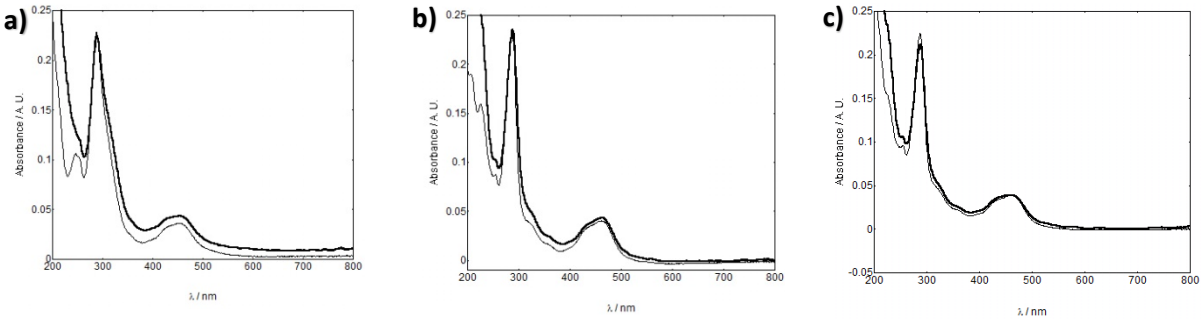
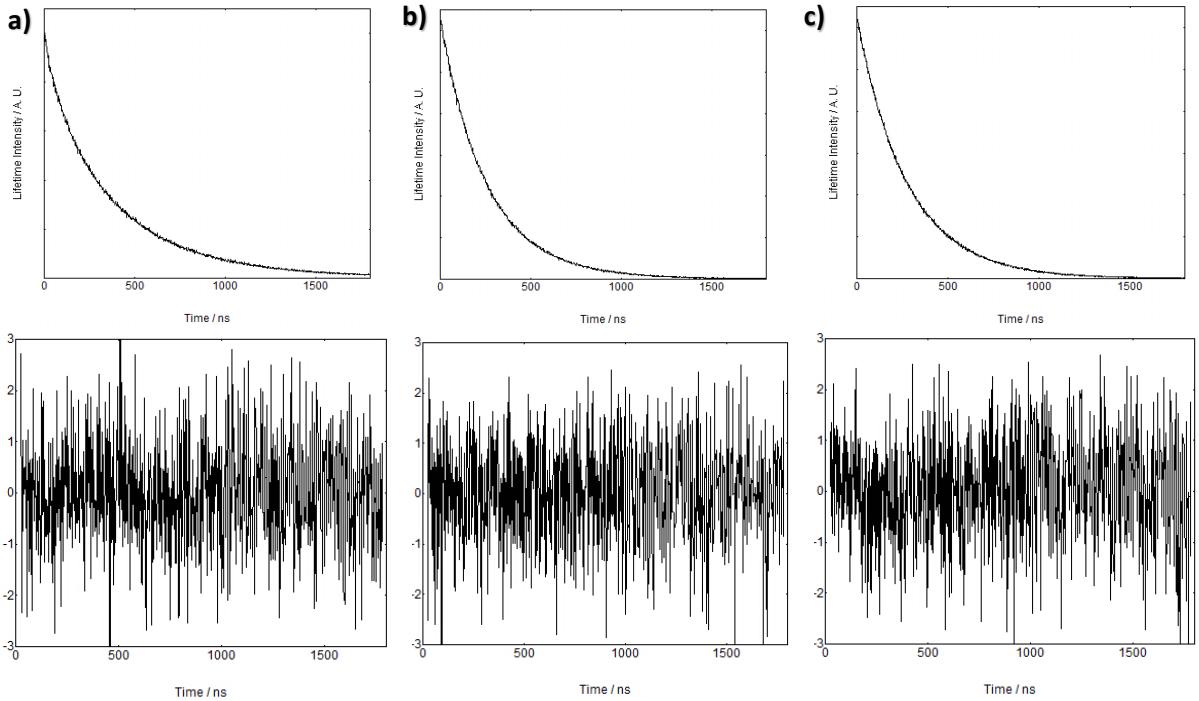
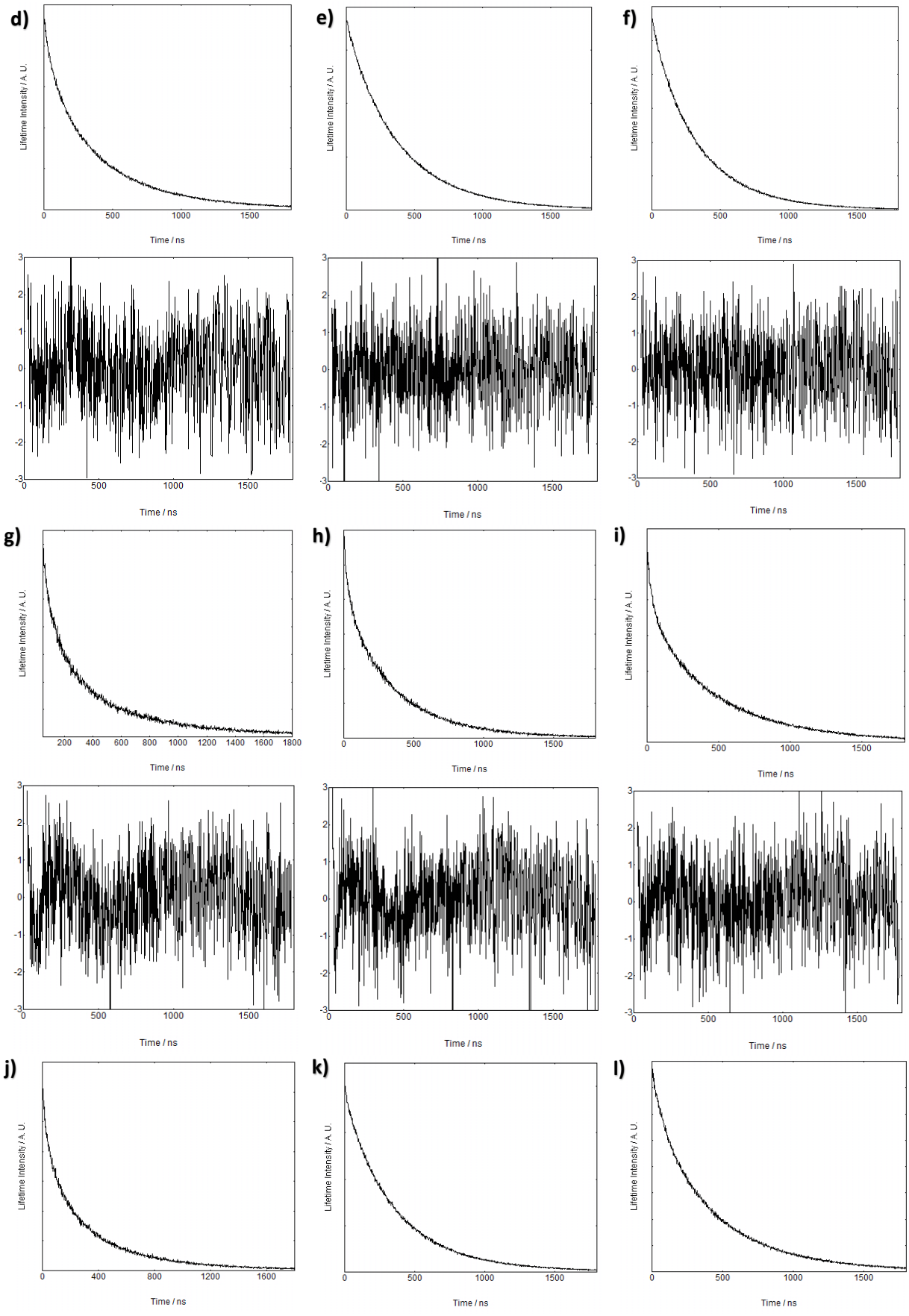


Figure S2: UV-Vis of the free complex RuS1 (a), RuS6 (b) and RuS12 (c) (thin line) and the complex with 10 µL 10% Zonyl FSA (thick line) in water. The spectra are taken from 200 – 800 nm.




d)
e)
f)
g)
h)
i)
j)
k)
l)
Lifetime Intensity / A. U.
Time / ns

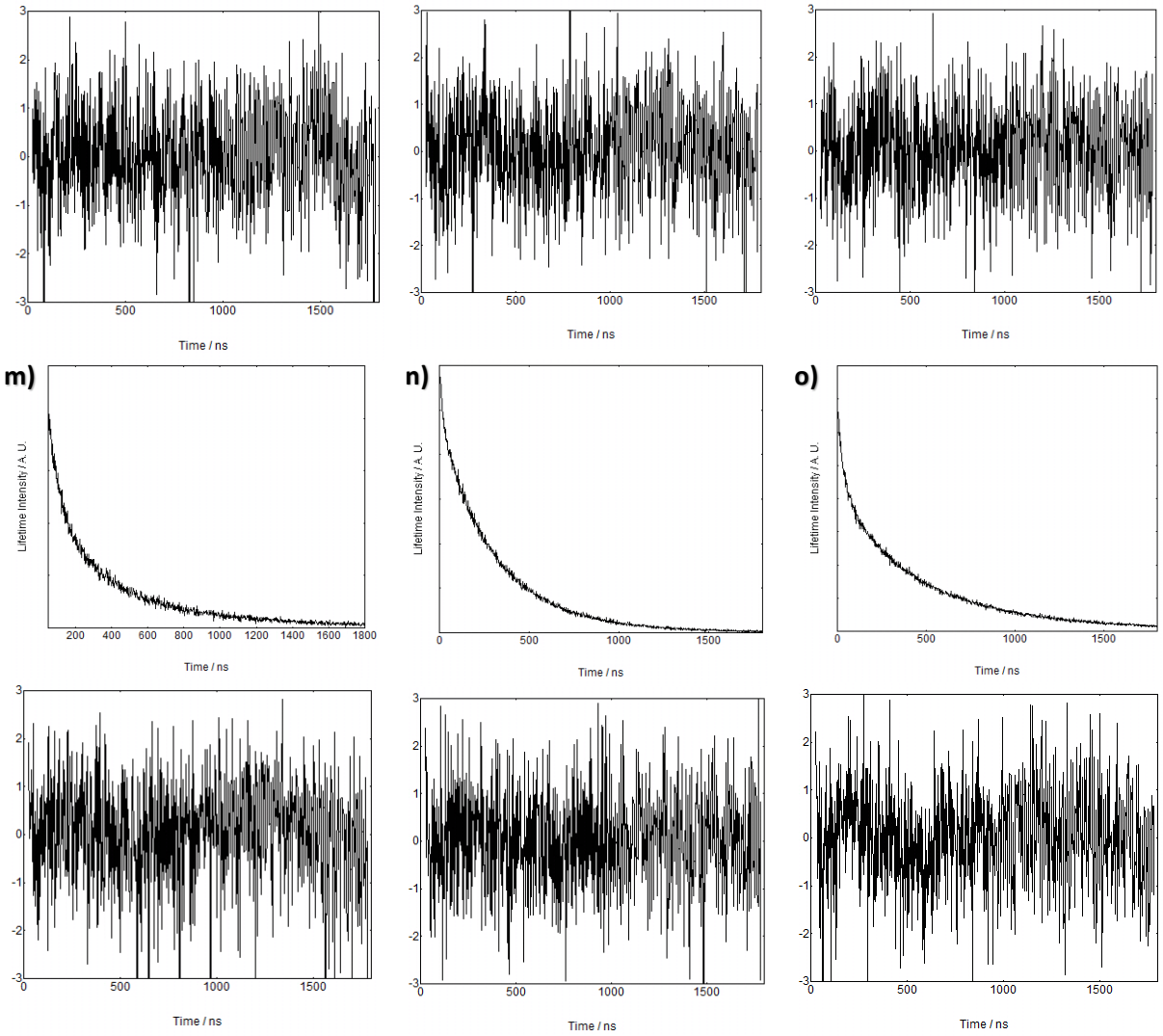


Figure S3: Luminescent lifetime decay (top) and fitting (bottom) of RuS1 (a), RuS6 (b), RuS12 (c), RuS1 + Z (d), RuS6 + Z (e), RuS12 + Z (f), RuS1·AuNP13 (g), RuS6·AuNP13 (h), RuS12·AuNP13 (i) , RuS1·AuNP50 (j), RuS6·AuNP50 (k), RuS12·AuNP50 (l), RuS1·AuNP100 (m), RuS6·AuNP100 (n) and RuS12·AuNP100 (o). λ_{exc} = 445 nm and λ_{det} = 650 nm.

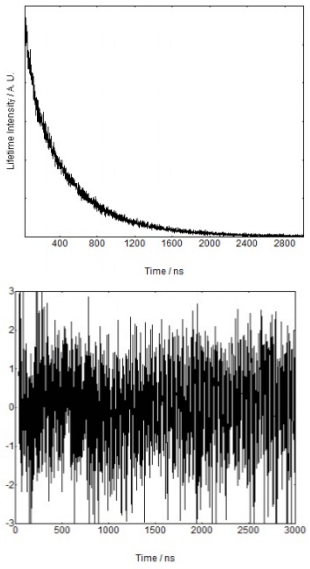


Figure S4: Luminescent lifetime decay (top) and fitting (bottom) of RuS12·AuNP13 with a 5 µs pulse. λ_{exc} = 445 nm and λ_{det} = 650 nm.

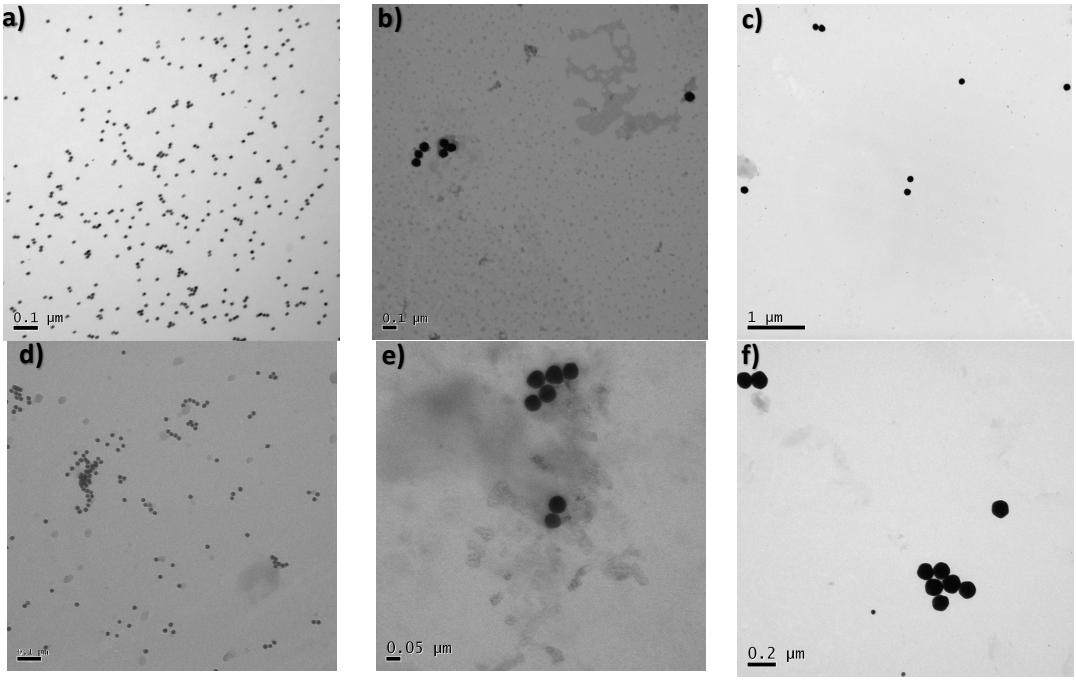


Figure S5: TEM images of AuNP13 (a), AuNP50 (b), AuNP100 (c), Z·AuNP13 (d), Z·AuNP50 (e) and Z·AuNP100 (f). Images are taken on the Jeol 1200 EX TEM.

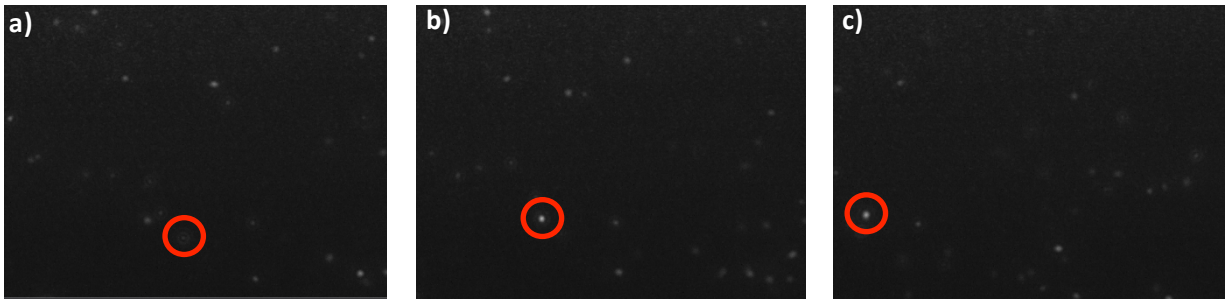


Figure S6: Video cuts of RuS12·AuNP100 at 5s (a), 7s (b) and 10s (c) on the NanoSight. λ_{exc} = 488 nm. Flow rate = 50 mL/h.

Table S3: Radiative and non-radiative contribution of the decay rate for RuS1·AuNP13, RuS1, RuS6·AuNP13, RuS6, RuS12·AuNP13 and RuS12. Q is the quantum yield and is measured directly from the integrating sphere. τ is the lifetime and is measured from a 445 nm pulsed laser. τ_N is the natural lifetime and is calculated from $\tau_N = \tau / Q$. R is the overall decay rate and is τ^{-1}. R_{rad} is the radiative decay rate and is τ_N^{-1}. R_{nonrad} is the non-radiative decay rate and is calculated from $R = R_{rad} + R_{nonrad}$.

	Q	τ /s (x 10^{-7})	τ_N /s (x 10^{-6})	R /s^{-1} (x 10^6)	R_{rad} /s^{-1} (x 10^5)	R_{nonrad} /s^{-1} (x 10^6)
RuS1·AuNP13	0.02	4.7	0.24	2.1 (2.127)	0.43 (0.425)	2.1 (2.085)
RuS1	0.02	4.2	0.21	2.4	0.48	2.3
RuS6·AuNP13	0.05	3.4	6.8	2.9	1.5	2.8
RuS6	0.02	2.4	0.12	4.2	0.83	4.1
RuS12·AuNP13	0.09	4.8	5.3	2.1 (2.083)	1.9 (1.875)	1.9 (1.895)
RuS12	0.02	2.8	0.14	3.6	0.71	3.5