

SUPPLEMENTARY INFORMATION

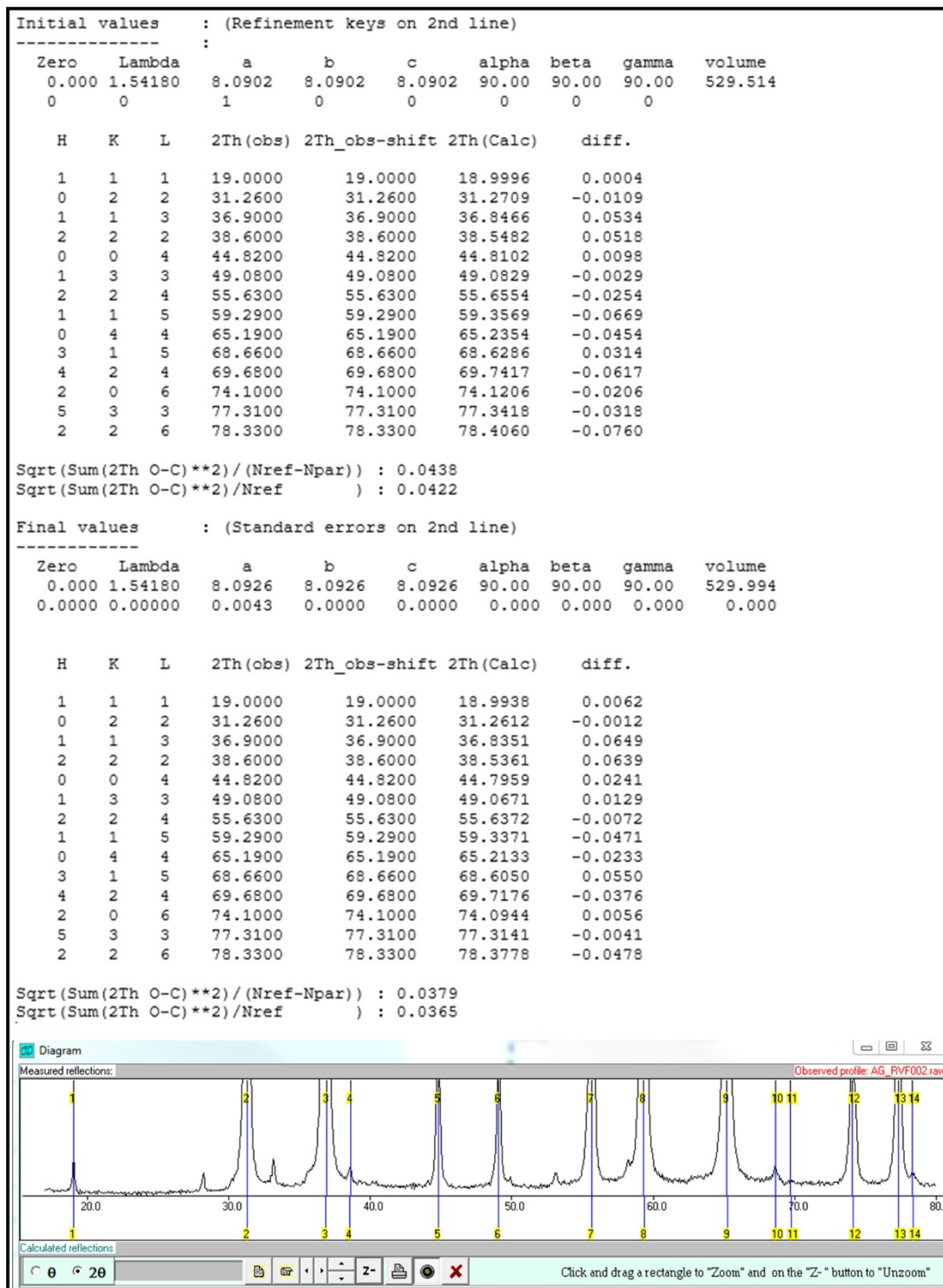


Figure S1: The full cell parameters obtained from the indexed patterns for ZnAl<sub>2</sub>O<sub>4</sub>.

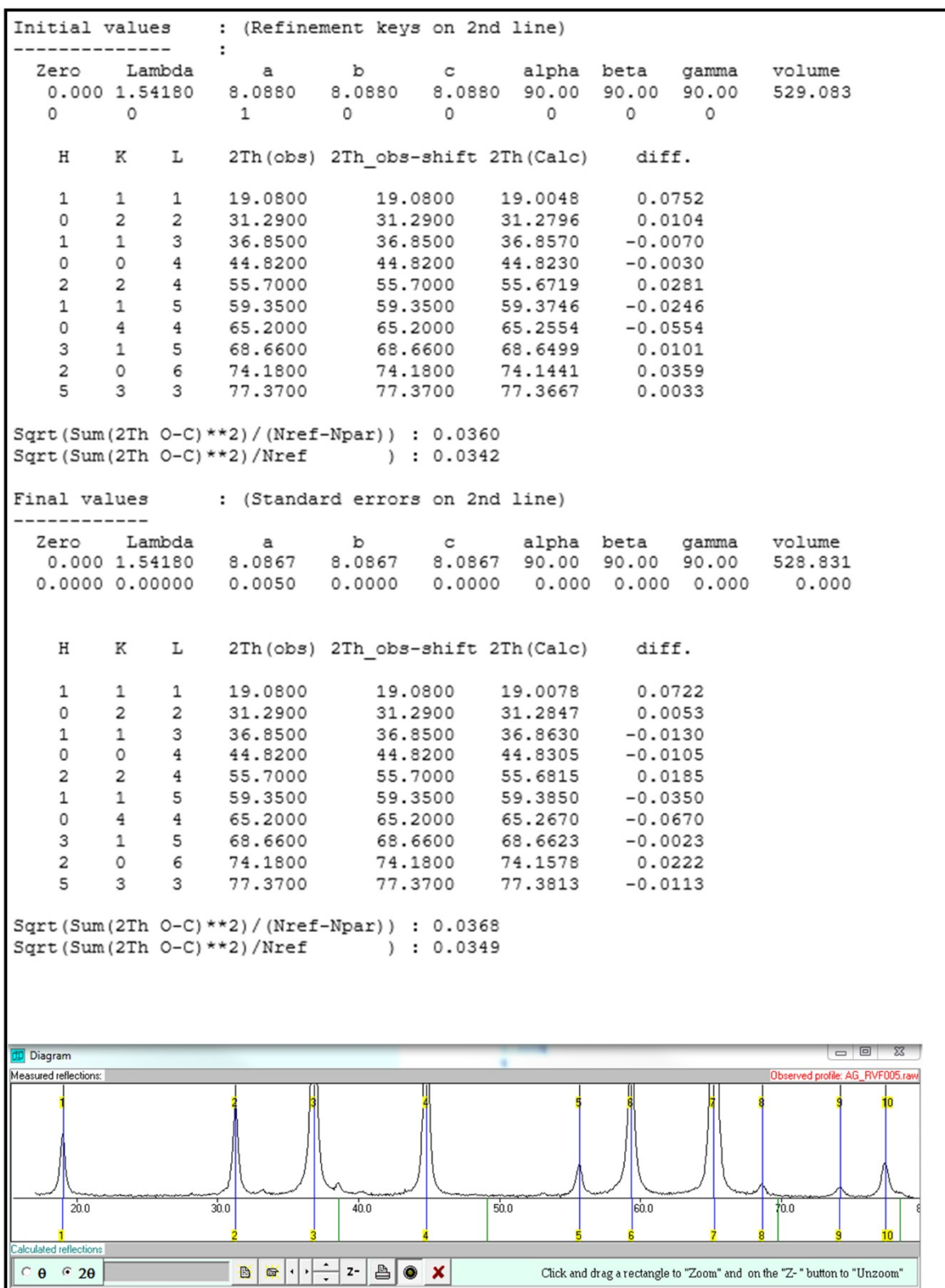


Figure S2: The full cell parameters obtained from the indexed patterns for  $\text{ZnAl}_2\text{O}_4:\text{Eu}^{3+}$ .

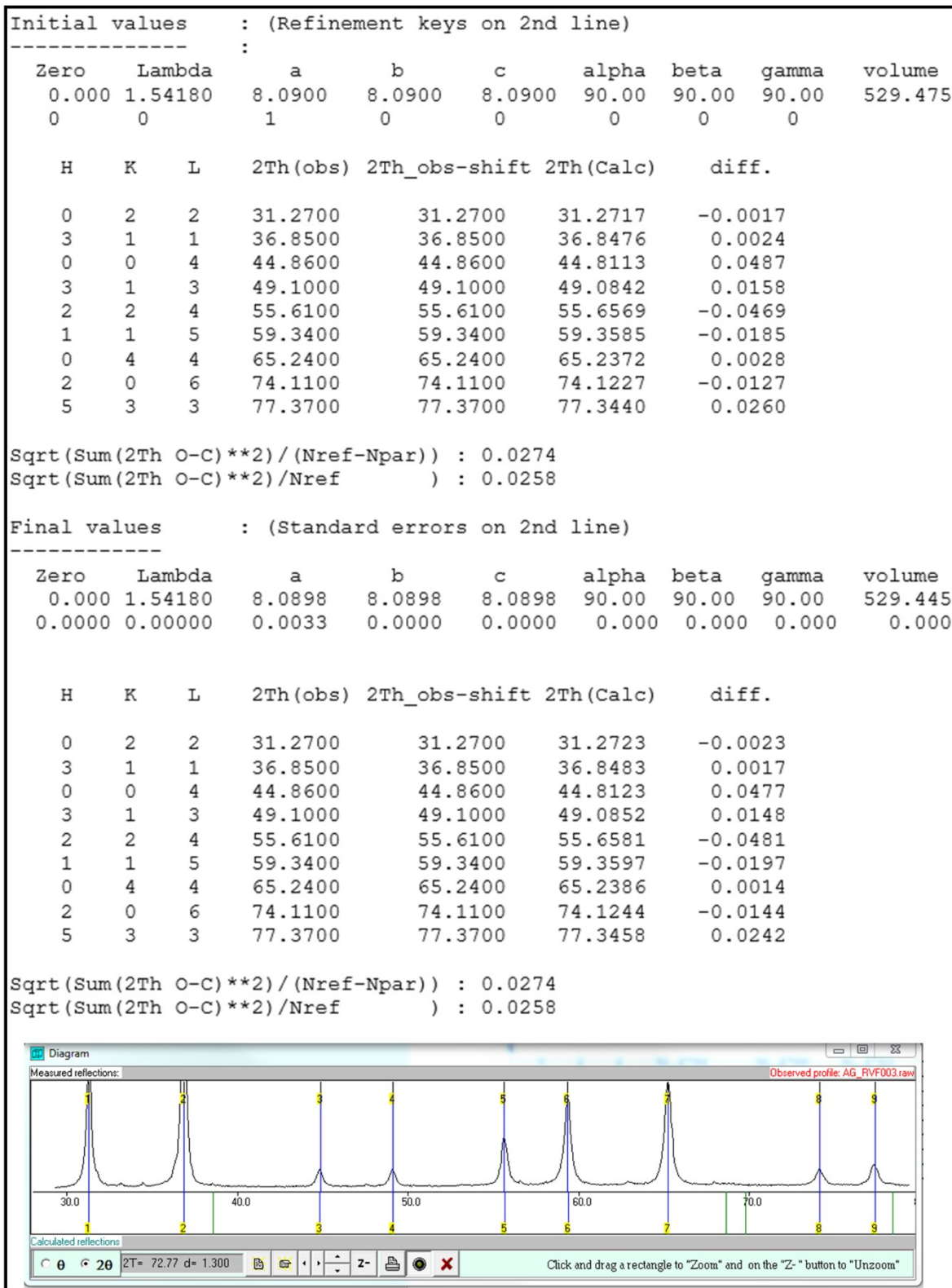
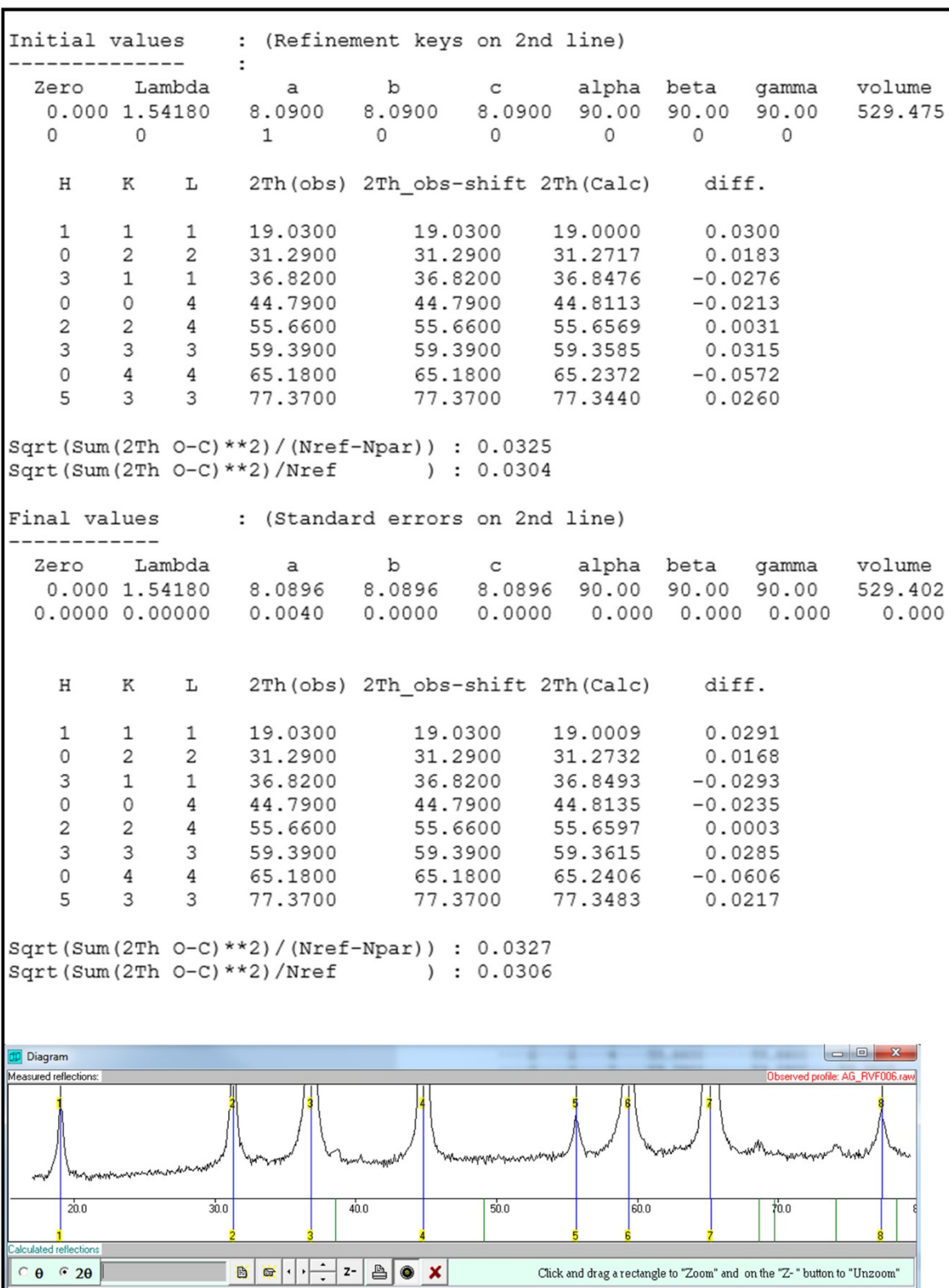


Figure S3: The full cell parameters obtained from the indexed patterns for  $MgAl_2O_4$ .



**Figure S4:** The full cell parameters obtained from the indexed patterns for  $\text{MgAl}_2\text{O}_4:\text{Eu}^{3+}$ .

**Table S1:** Data fits of emission and excitation spectra of ZAOE and MAOE

<b>ZAOE</b>									
<b>Emission</b>					<b>Excitation</b>				
<b>Position (cm<sup>-1</sup>)</b>	<b>Position (nm)</b>	<b>FWHM (cm<sup>-1</sup>)</b>	<b>Intensity (cm<sup>-1</sup>)</b>	<b>Energy (eV)</b>	<b>Position (cm<sup>-1</sup>)</b>	<b>Position (nm)</b>	<b>FWHM (cm<sup>-1</sup>)</b>	<b>Intensity (cm<sup>-1</sup>)</b>	<b>Energy (eV)</b>
14178.7	705	211.8	0.683	1.758	18901.4	529	706,0	0.172	2.343
14398.0	695	339.5	0.727	1.785	21582.9	463	701,6	0.657	2.676
15340.8	652	550.7	0.658	1.902	23701.6	422	679,4	1.370	2.939
16156.6	619	425.2	7.160	2.003	25328.5	395	937,1	1.460	3.140
16664.7	600	146.2	0.277	2.066	26243.7	381	748,5	0.299	3.254
16881.4	592	302.9	0.859	2.093	35392.7	283	6959	41.48	4.388
17237.0	580	309.7	0.439	2.137					

<b>MAOE</b>									
<b>Emission</b>					<b>Excitation</b>				
<b>Position (cm<sup>-1</sup>)</b>	<b>Position (nm)</b>	<b>FWHM (cm<sup>-1</sup>)</b>	<b>Intensity (cm<sup>-1</sup>)</b>	<b>Energy (eV)</b>	<b>Position (cm<sup>-1</sup>)</b>	<b>Position (nm)</b>	<b>FWHM (cm<sup>-1</sup>)</b>	<b>Intensity (cm<sup>-1</sup>)</b>	<b>Energy (eV)</b>
14159.9	706	179.2	1.590	1.756	19262.0	519	823.0	0.293	2.388
14324.8	698	421.2	3.180	1.776	22087.4	453	730.2	0.863	2.738
15299.0	654	471.2	1.910	1.897	24278.7	412	698.5	1.310	3.010
16152.8	619	443.9	21.42	2.003	25998.4	385	916.9	2.200	3.,223
16664.7	600	143.3	0.816	2.066	26849.7	372	923.8	0.846	3.329
16874.1	593	292.5	2.670	2.092	36929.9	271	7450	53.79	4.579
17213.8	581	312.8	1.370	2.134					

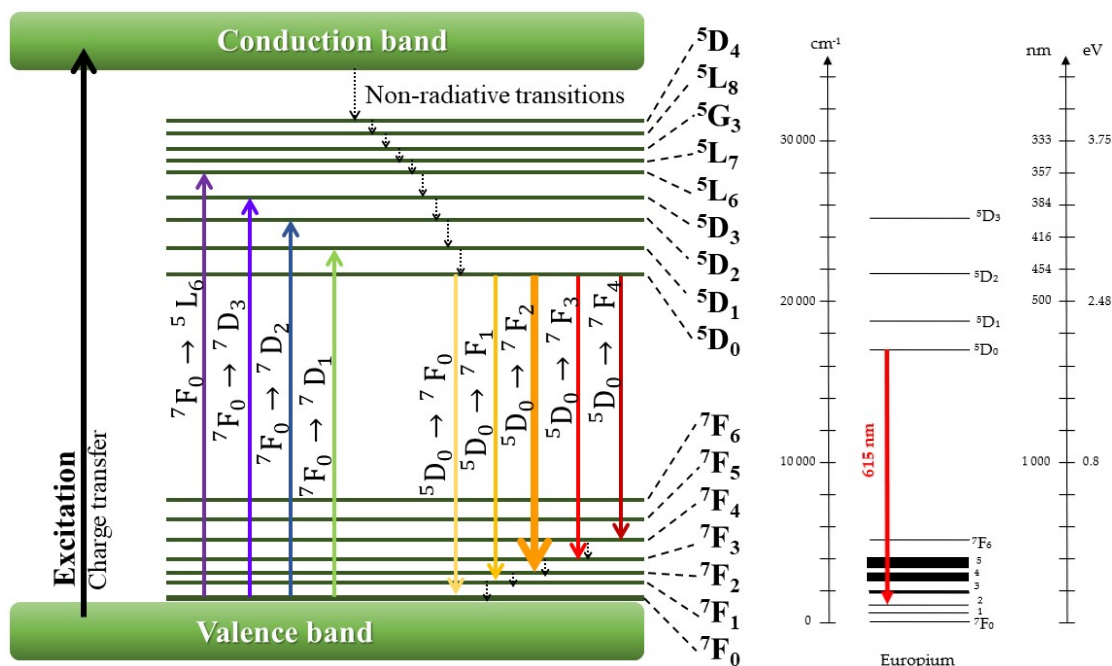


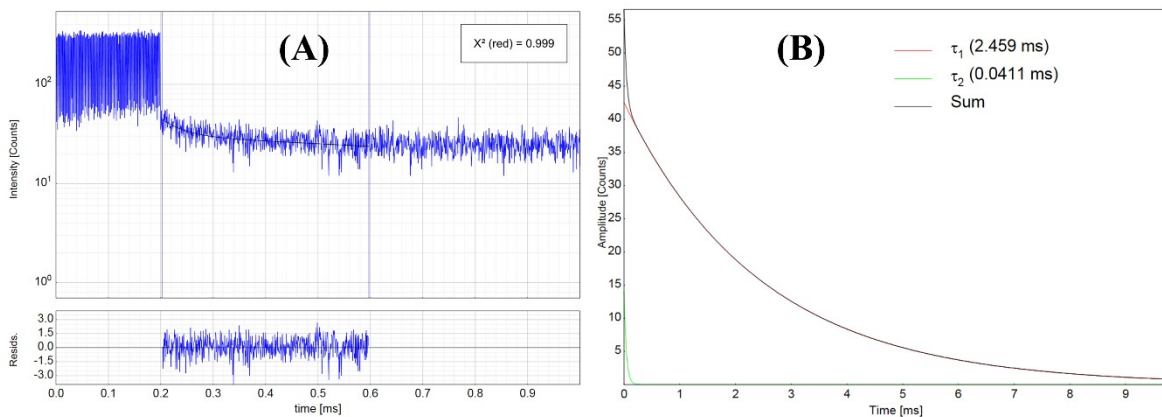
Figure S5: Energy level diagram of Eu<sup>3+</sup>. Based on M. Dimitrievska et. at. [1]

Table S2a: Spectral parameters of EuDS samples

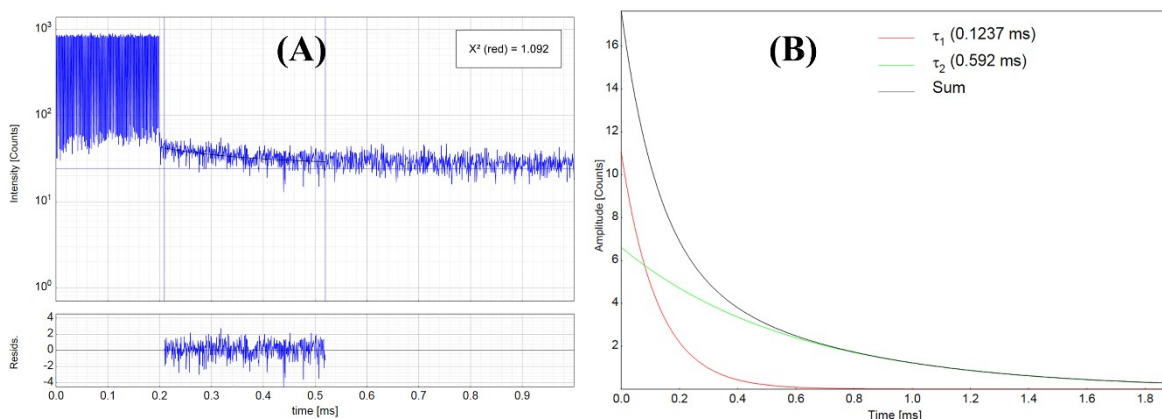
Sample	Judd-Ofelt Intensity Parameters		Radiative Transition Probabilities <sup>5</sup> D <sub>0</sub> → <sup>7</sup> F <sub>J</sub> (J = 1, 2, 4)		
	$\Omega_2$ (10 <sup>-20</sup> cm <sup>2</sup> )	$\Omega_4$ (10 <sup>-20</sup> cm <sup>2</sup> )	$A_1$ (s <sup>-1</sup> )	$A_2$ (s <sup>-1</sup> )	$A_4$ (s <sup>-1</sup> )
	ZAOE	8.651	4.459	78.97	434.26
MAOE	8.261	4.679	72.20	373.86	104.50

Table S2b: Spectral parameters of EuDS samples

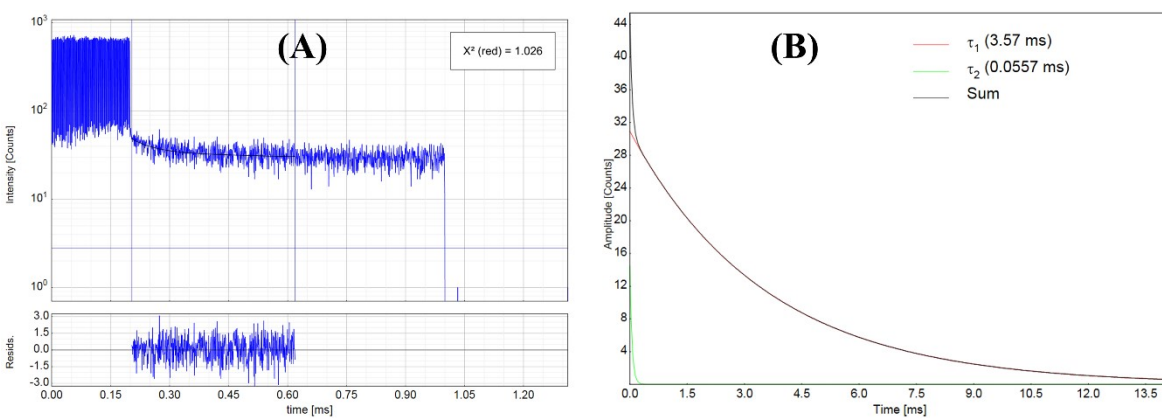
Sample	$\tau_{rad}$ (ms)	Branching Ratio <sup>5</sup> D <sub>0</sub> → <sup>7</sup> F <sub>J</sub> (J = 1, 2, 4)			Stimulated emission cross-section <sup>5</sup> D <sub>0</sub> → <sup>7</sup> F <sub>J</sub> (J = 1, 2, 4)		
		$\beta_1$	$\beta_2$	$\beta_4$	$\sigma_1$ (10 <sup>-22</sup> cm <sup>2</sup> )	$\sigma_2$ (10 <sup>-22</sup> cm <sup>2</sup> )	$\sigma_4$ (10 <sup>-22</sup> cm <sup>2</sup> )
		ZAOE	1.56	12.7%	69.6%	17.8%	1.12
MAOE	1.77	13.1%	67.9%	19.0%	1.11	7.04	3.46



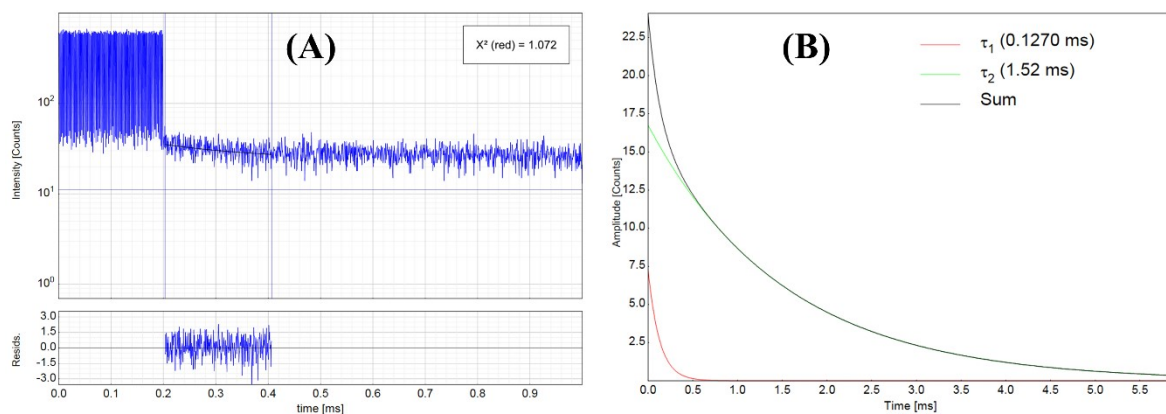
**Figure S6.** ZAOE. (A) *TCSPC* fitting and residual. (B) Fitted decay and exponential components.



**Figure S7.** ZAOE-AgMPCS. (A) *TCSPC* fitting and residual. (B) Fitted decay and exponential components.



**Figure S8.** MAOE. (A) *TCSPC* fitting and residual. (B) Fitted decay and exponential components.



**Figure S9.** MAOE-AgMPCS. (A) *TCSPC* fitting and residual. (B) Fitted decay and exponential components.

## Reference

- [1] M. Dimitrievska, T.B. Ivetić, A.P. Litvinchuk, A. Fairbrother, B.B. Miljević, G.R. Štrbac, A. Pérez Rodríguez, S.R. Lukić-Petrović, *J. Phys. Chem. C* 120 (2016) 18887–18894.