Electronic Supplementary Material (ESI) for New Journal of Chemistry.
This journal is © The Royal Society of Chemistry and the Centre National de la Recherche Scientifique 2017

Supporting Information

Effects of electron withdrawing groups in imidazole-phenanthroline ligands and their influence on photophysical properties of Eu^{III} complexes for white light emitting diodes

Boddula Rajamouli,[a] Rachna Devi,[a†] Abhijeet Mohanty,[a†] Venkata Krishnan,[b] Vaidyanathan Sivakumar*[a]

[a] Department of Chemistry, National Institute of Technology Rourkela, Rourkela, 769008, Odisha, India.

[b] Advanced Material Research Center, School of Basic Sciences, Indian Institute of Technology, Mandi - 175 005, Himachal Pradesh, India.

Contents

1. Experimental Section
2. **Fig. S1** The FT-IR spectra of the ligands with their functional groups.
3. **Fig. S2** The FT-IR spectra of the Eu(III) complexes with their functional groups and its comparison with $Eu(TTT)_3 2H_2O$.
4. **Fig. S3** The theoretical UV spectra of the ligands in gas phase and DCM solution.
5. **Fig. S4** The band gap of the ligands by diffuse reflectance spectra (DRS).
6. **Fig. S5** The band gap of the Eu(III) complexes by diffuse reflectance spectra (DRS).
7. **Table 1.** The PL intensity of the magnetic and electric dipole transitions of the complexes. Their ratio of the Eu(III) complexes in solution form as well as solid form.
8. **Fig. S6** The bar graph for asymmetric ratio of the complexes, 1Eu, 2Eu and 3Eu in solution.
9. **Fig. S7** The bar graph for asymmetric ratio of the complexes, 1Eu, 2Eu and 3Eu in solid.
10. **Fig. S8** The life time of the ligand, Phen-Ph-Ph in different solvents.
11. **Fig. S9** The life time of the ligand, Phen-mCF_3-Ph in different solvents.
12. **Fig. S10** The life time of the ligand, Phen-pCF_3-Ph in different solvents.
13. **Fig. S11** The life time of thin film of the Eu-complex, $Eu(TTA)_3$Phen-Ph-Ph in different concentrations .
14. **Fig. S12** The life time of thin film of the Eu-complex, $Eu(TTA)_3$Phen-mCF_3-Ph in different concentrations.
15. **Fig. S13** The life time of thin film of the Eu-complex, $Eu(TTA)_3$Phen-pCF_3-Ph in different concentrations.
16. **Table S2** The CIE color coordinates calculated out comes of the Eu(III) complexes and their intensity ratios in thin film.
17. **Table S3** The CIE color coordinates calculated results from the PL emission spectra of the Eu(III) complexes in solution at different excitation source.
18. **Table S4** The CIE color coordinates calculated results from the PL emission spectra of the ligands in solution form at different excitation source.
19. **Table S5** The CIE color coordinates calculated results from the PL emission spectra of the Eu(III) complexes in solid form at different excitation source.
20. **Table S6** The CIE color coordinates calculated results from the PL emission spectra of the ligands in solid form at different excitation source.
21. **Fig. S14** The energy levels of the complex and corresponding ligands.

22. **Table S7** The HOMO-LUMO and singlet triplet calculations of the ligands.
23. **Fig. S15** Synthesised Eu(III) complex, ligand and Eu $(TTA)_3$ under normal light, a, b, c (left) and under UV lamp (right) in solution a, b, c; respectively. Thin film of (d) $Eu(TTA)_3$Phen-R-Ph (3 complexes), solid of (e) Phen-R-Ph (3 ligands) and thin film of (f) ligands.
24. **Fig. S16** The ^{1}H (top) and ^{13}C (bottom) NMR of the 1L ligand.
25. **Fig. S17** The ^{1}H (top) and ^{13}C (bottom) NMR of the 2L ligand.
26. **Fig. S18** The ^{1}H (top) and ^{13}C (bottom) NMR of the 3L ligand.
27. **Fig. S19** The mass spectrum of the 1L ligand.
28. **Fig. S20** The mass spectrum of the 1Eu complex.
29. **Fig. S21** The mass spectrum of the 2L ligand.
30. **Fig. S22** The mass spectrum of the 2Eu complex.
31. **Fig. S23** The mass spectrum of the 3L ligand.
32. **Fig. S24** The mass spectrum of the 3Eu complex.
33. **Fig. S25** The PLQY of the thin film of the complex, $Eu(TTT)_3$Phen-pCF_3-Ph. Red-reference, Blue-direct and Green-indirect.
34. **Fig. S26** The emission spectrum of ligands, 1L, 2L and 3L and UV-vis absorption spectra of the TTA at room-temperature.
35. **Fig. S27** The phosphorescence emission spectrum of ligands, Gd(III) complex with 1L, 2L and 3L at 77 K.
36. **Fig. S28** The schematic diagram of the energy transfer process in the Eu(III) complex to rach Eu(III) metal ion via ligand and TTA levels.
37. **Fig. S29** The UV-absorption spectra of the ligands (left) and corresponding Eu^{III} complexes (right).
38. **Fig. S30** The PL excitation and emission spectra of ligands, 1L, 2Land 3L in solution (left) and solid form (right).
39. **Table S8** The calculated $A_{0\text{-}J}$ parameters and their experimental branching ratios ($\sigma_{1\text{-}3}$ and $\beta_{1\text{-}3}$) of the complexes.
40. **Table S9** xyz coordinates of the optimized ligand, 1L (Phen-Ph-Ph).
41. **Table S10** xyz coordinates of the optimized ligand, 2L (Phen-mCF_3-Ph).
42. **Table S11** xyz coordinates of the optimized ligand, 3L (Phen-pCF_3-Ph).
43. **Table S12.** Bi-exponential fitting curve parameters in solution and solid for the complexes and ligands.

44. Table S13. Absorption, excitation and emission of the ligands and the corresponding complexes in solution as well as solid.

Experimental Section:

Materials: All the commercially obtained chemicals were used directly without any further modifications unless stated otherwise. 4,4,4-Trifluoro-1-(2-thienyl)-1,3-butanedione (TTA, 99.99%), tetrabutylammonium perchlorate (n-Bu_4NClO_4, 99.9%) electrolyte were purchased from Sigma-Aldrich chemicals company. Europium (III) oxide (99.99%), 1, 10-Phenanthroline, aniline and benzaldehyde were purchased from Alfa Aesar, 4-(trifluoromethyl)benzenamine, 3-(trifluoromethyl)benzenamine, were purchased from Avra chemicals. Thin layer Chromatography with silica gel 60 F_{254} Aluminium plates (Merk) was used to monitor the reactions. Column chromatography was conducted using 100-200 mesh silica to get the pure compound.

Measurement: Nuclear magnetic resonance (^{1}H-, ^{13}C-, ^{19}F NMR) spectra were recorded with an AV 400 Avance-III 400MHz Fourier Transform nuclear magnetic resonance (FT-NMR) Spectrometer Bruker Biospin International, Switzerland, in deuterated chloroform($CDCl_3$) or dimethyl sulfoxide solution (based on the solubility nature). Chemical shifts were estimated relative to the tetramethylsilane (TMS) standard reference. Fourier Transform Infrared (FT-IR) spectra were recorded with a Perkin Elmer, USA/ RX-I FTIR spectrophotometer and elemental analyses were measured by Elementar Analysen Systeme, Germany/Vario EL spectrometer. A single crystal of ligands, a suitable crystal was selected and structures were performed on a Supernova, Dual, Cu at zero, Eos diffractometer. The crystal was kept at 293(2) K during data collection. Using Olex2, the structure was solved with the ShelXS structure solution program using Direct Methods and refined with the ShelXL refinement package using Least Squares minimisation.

Photophysical properties: Absorption analysis was done by using the UV-Visible spectrometer (Shimadzu Corporation, Japan or UV-2450 Perkin Elmer, USA/Lamda 25 and Lamda Perkin Elmer) for a solution and solid form (diffuse reflectance spectra, DRS). The PL excitation and emission spectrum in both solid and solution phase for all the samples were recorded with a Horiba Jobin Yvon, USA/Fluoromax 4P spectrophotometer with a 150W xenón lamp as an excitation source. Thin films were prepared by a spin coating method using a spin NXG P1A instrument and measured the PL by spectrofluorimetry. The PL quantum yield (PLQY) of the complex in the form of a solution, a thin film (with a different ratio (PMMA Vs Eu-complexes) and solid were measured with Edinburgh spectrofluorometer FS5. A life time of the Eu^{III} complexes and ligands were measured at 298 K with Edinburgh Instruments FLS 980 based on the time correlated single photon counting technology upon the excitation at a suitable wavelength for ligands and complexes, respectively. A pulsed xenon lamp was used as the excitation source and the signals were detected with a photomultiplier. The triplet energy of the synthesized ligand was estimated by measuring the phosphorescence spectra of the Gd-complex of the ligand at 77 K by using Edinburgh FLS 920 spectrofluorimeter, UK system consists of a 450 w Xenon lamp (Xe 900) mounted in an air cooled lamp housing with a built in de-ozoniser filter.

Electrochemical properties: Cyclic voltammetry was carried out using AUTOLAB 302N Modular potentiostat at room temperature in N, N-dimethylformamide (DMF) with glass-carbon rod as working, Pt wire as auxiliary and Ag/AgCl wire as reference electrodes. Bu_4NClO_4 (0.1 M) in DMF was used as the supporting electrolyte and scan rate was maintained as 100 mV s^{-1}. All the ligand structures were optimized using density functional theory (DFT) and their respective theoretical UV-Vis spectra were computed using B3LYP/6-31(G) level of theory. The ground state geometry of the ligand structures was confirmed and the ligands were excited vertically to estimate the first excited state using

time-dependent DFT (TD-DFT). The same procedure was followed to obtain the triplet excited states from which PL spectra of the compounds were derived. The HOMO and LUMO levels were also been calculated.

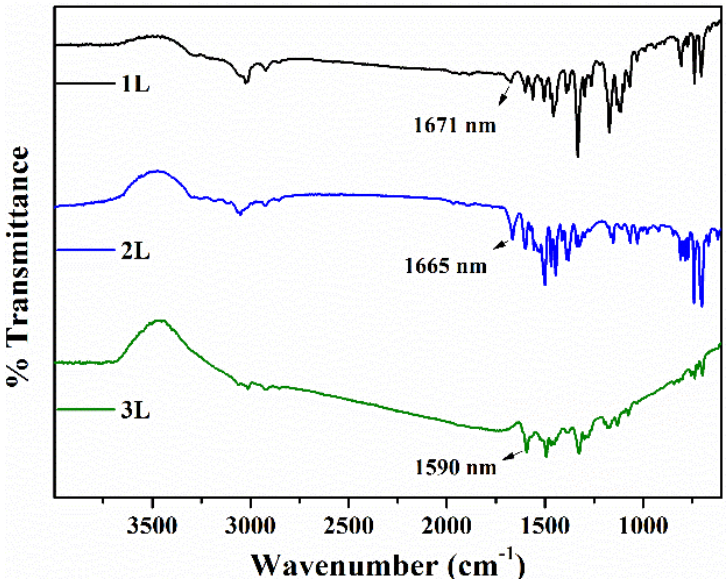


Fig. S1 The FT-IR spectra of the ligands with their functional groups.

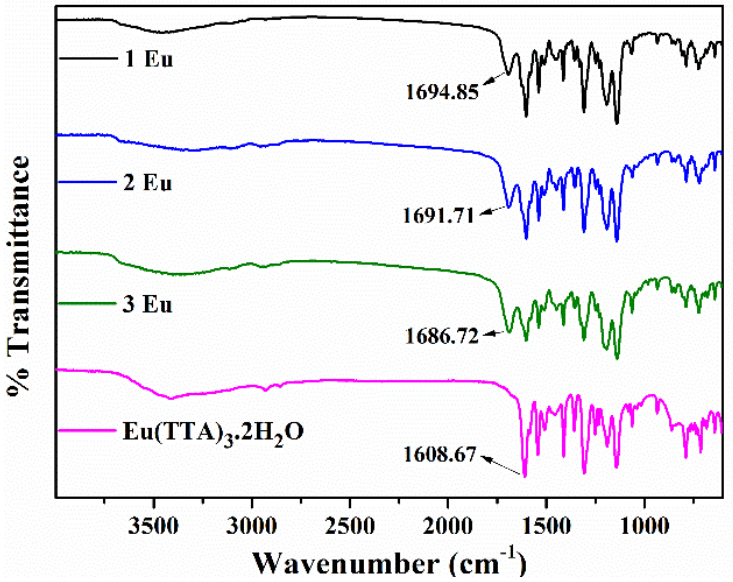


Fig. S2 The FT-IR spectra of the Eu(III) complexes with their functional groups and its comparison with $Eu(TTT)_3 2H_2O$.

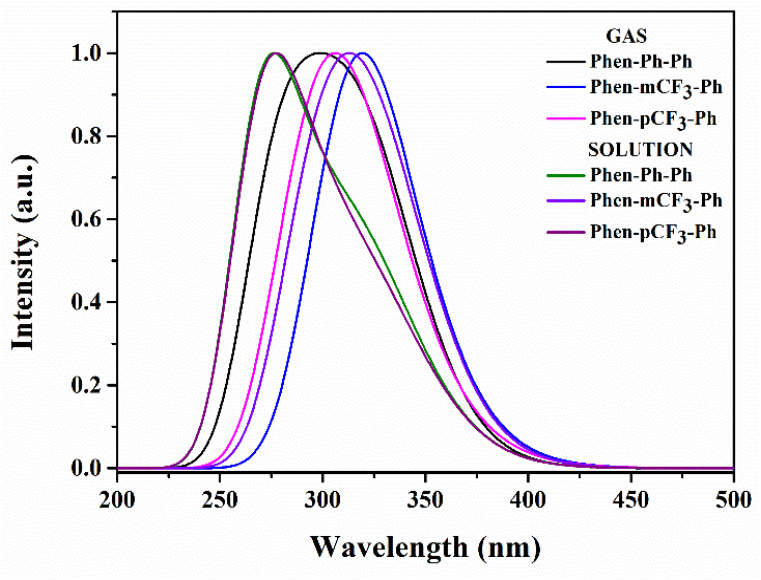


Fig. S3 The theoretical UV spectra of the ligands in gas phase and DCM solution.

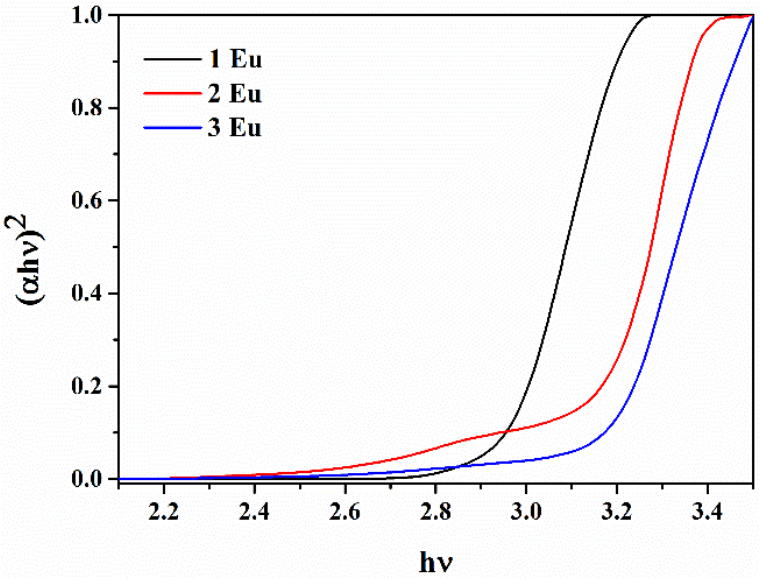


Fig. S4 The band gap of the ligands by diffuse reflectance spectra (DRS).

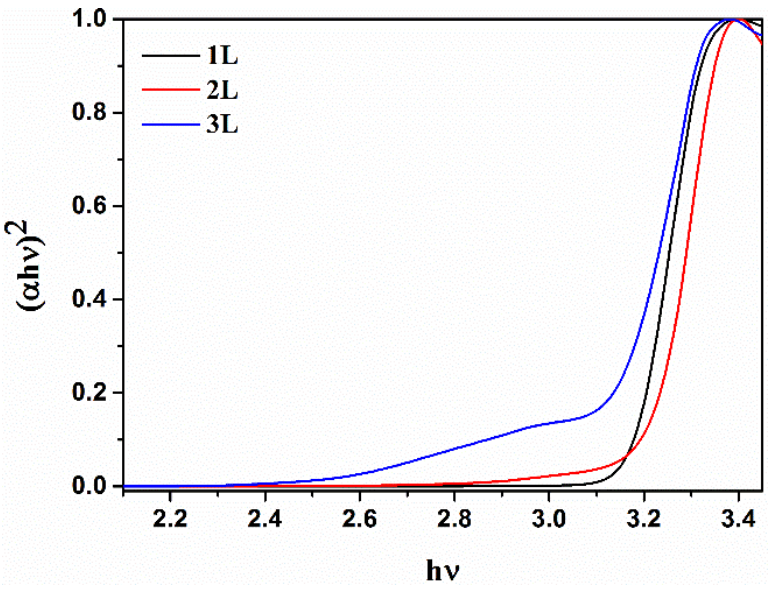


Fig. S5 The band gap of the Eu(III) complexes by diffuse reflectance spectra (DRS).

Table 1. The PL intensity of the magnetic and electric dipole transitions of the complexes. Their ratio of the Eu(III) complexes in solution form as well as solid form.

Solution Phase				
S.No.	**Complex name**	**$^5D_0$-$^7F_1$ (a.u.)**	**$^5D_0$-$^7F_2$ (a.u.)**	**Ratio**
1.	Eu(TTA)$_3$Phen-Ph-Ph	280058.74	3505695.0	12.52007
2.	Eu(TTA)$_3$Phen-mCF$_3$-Ph	1629022.00	2274303.8	13.961201
3.	Eu(TTA)$_3$Phen-pCF$_3$-Ph	1097453.91	16787376.4	15.2967

Solid Phase				
1.	Eu(TTA)$_3$Phen-Ph-Ph	8280000	531000000	6.41304
2.	Eu(TTA)$_3$Phen-mCF$_3$-Ph	3940000	41800000	10.6091
3.	Eu(TTA)$_3$Phen-pCF$_3$-Ph	723554.76	11400000	15.756

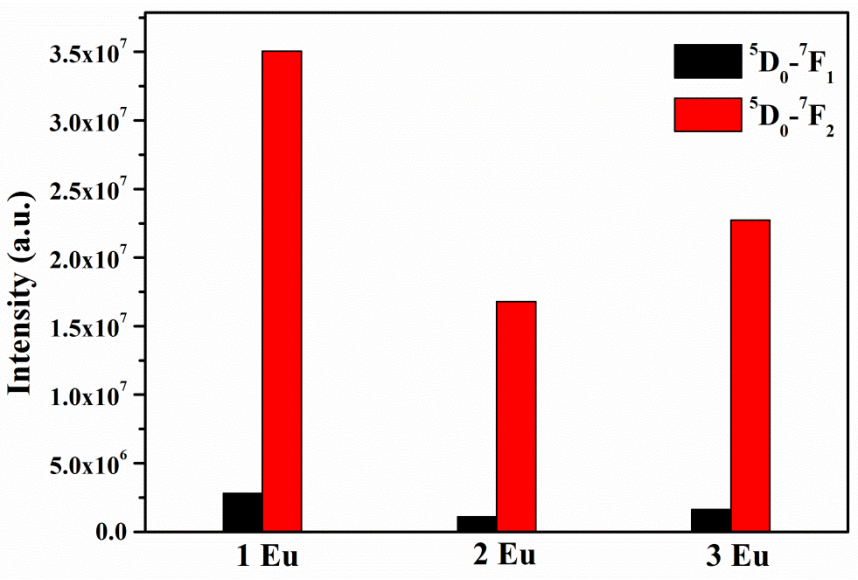


Fig. S6 The bar graph for asymmetric ratio of the complexes, 1Eu, 2Eu and 3Eu in solution.

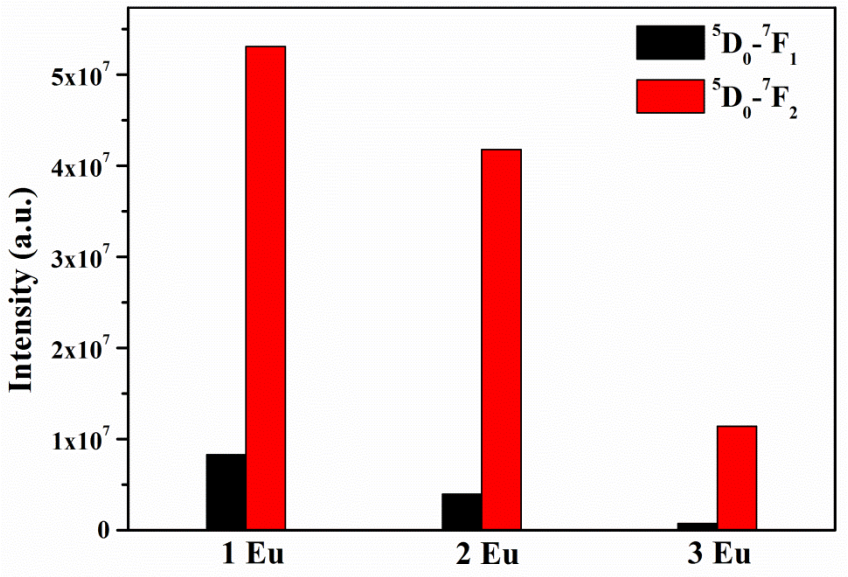


Fig. S7 The bar graph for asymmetric ratio of the complexes, 1Eu, 2Eu and 3Eu in solid.

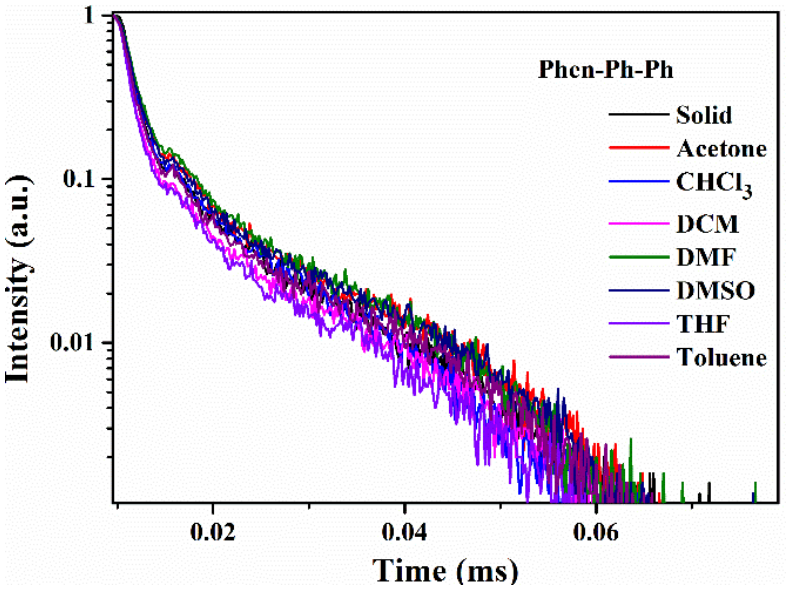


Fig. S8 The life time of the ligand, Phen-Ph-Ph in different solvents.

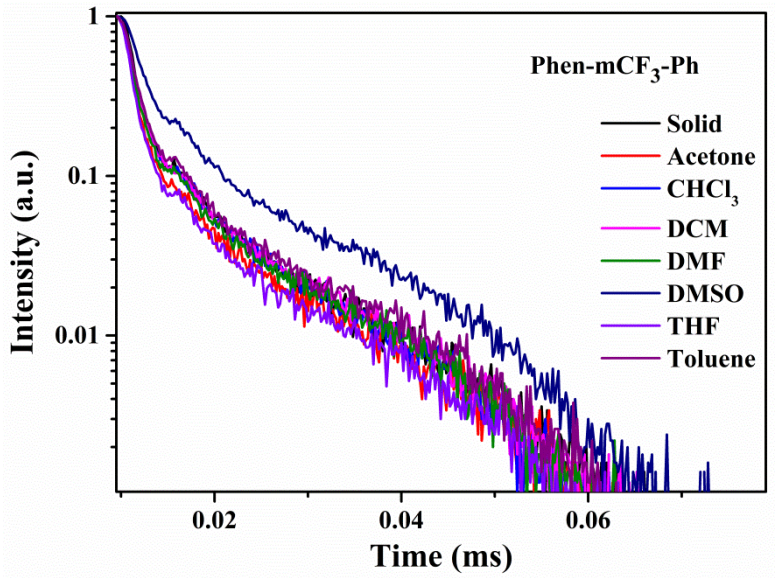


Fig. S9 The life time of the ligand, Phen-mCF_3-Ph in different solvents.

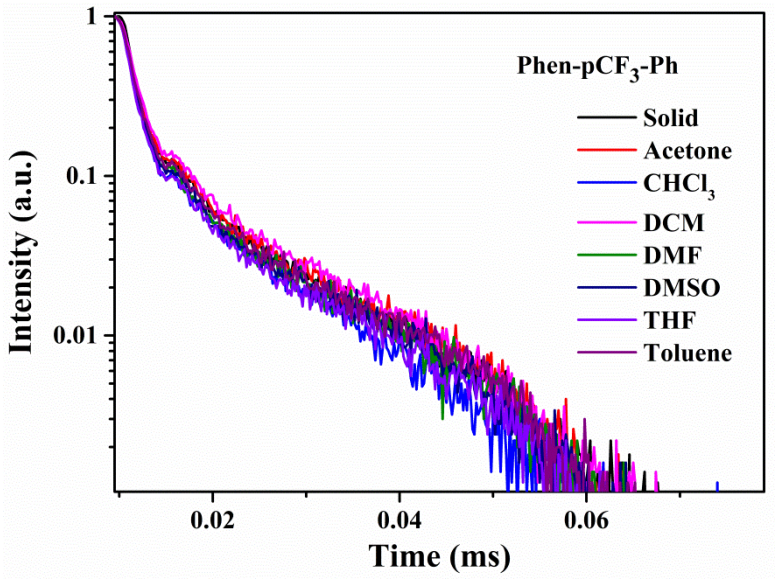


Fig. S10 The life time of the ligand, Phen-pCF_3-Ph in different solvents.

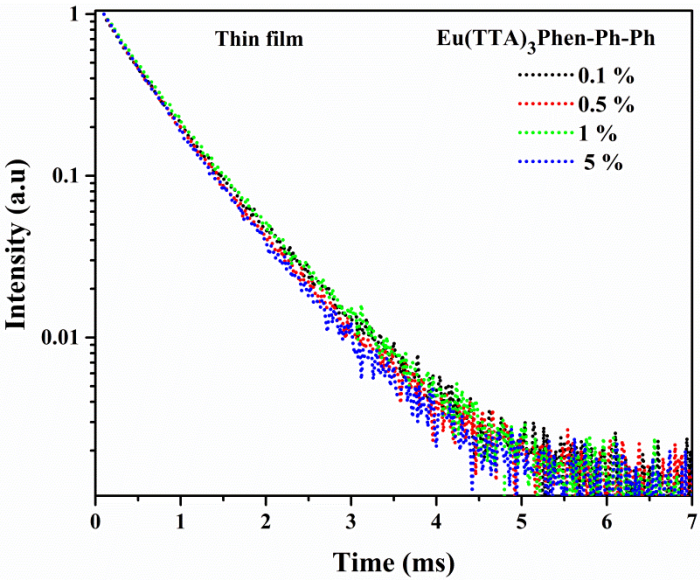


Fig. S11 The life time of thin film of the Eu-complex, $Eu(TTA)_3$Phen-Ph-Ph in different concentrations .

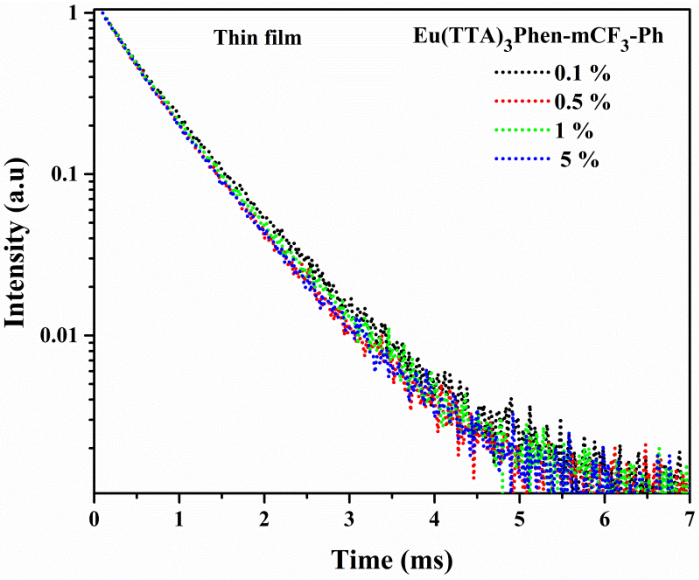


Fig. S12 The life time of thin film of the Eu-complex, $Eu(TTA)_3Phen\text{-}mCF_3\text{-}Ph$ in different concentrations.

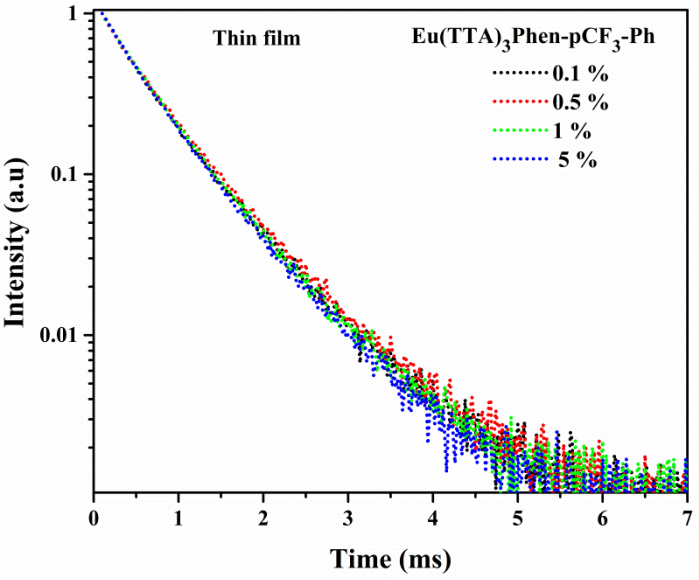


Fig. S13 The life time of thin film of the Eu-complex, $Eu(TTA)_3Phen\text{-}pCF_3\text{-}Ph$ in different concentrations.

Table S2. The CIE color coordinates calculated out comes of the Eu(III) complexes and their intensity ratios in thin film.

	Thin film			
Complex	Asym. Ratio	CIE		FWHM
		x	y	
1Eu 0.1%	9.15	0.619	0.379	9.42
0.5%	8.17	0.633	0.365	10.58
1.0%	5.16	0.637	0.361	13.63
5.0%	2.63	0.6341	0.365	17.91
2Eu 0.1%	7.50	0.617	0.381	10.37
0.5%	5.32	0.625	0.373	13.50
1.0%	4.56	0.633	0.365	14.19
5.0%	2.94	0.637	0.361	17.13
3Eu 0.1%	9.45	0.575	0.421	9.56
0.5%	7.69	0.579	0.417	10.68
1.0%	4.74	0.582	0.415	13.91
5.0%	3.09	0.586	0.411	16.89

Table S3 The CIE color coordinates calculated results from the PL emission spectra of the Eu(III) complexes in solution at different excitation source.

Solution				
Compounds	**x**	**y**		**Excitation wavelength (nm)**
$Eu(TTA)_3$Phen-Ph-Ph	0.625007	0.325309		291
	0.625347	0.338608		372
$Eu(TTA)_3$Phen-mCF_3-Ph	0.59976	0.316711		273
	0.641875	0.332231		340
	0.6418866	0.332868		371
$Eu(TTA)_3$Phen-pCF_3-Ph	0.644295	0.333256		342
	0.631659	0.327631		374

Table S4. The CIE color coordinates calculated results from the PL emission spectra of the ligands in solution form at different excitation source.

Solution				
Compounds	**x**	**y**		**Excitation wavelength (nm)**
Phen-Ph-Ph	0.218529	0.138168		246
	0.159785	0.0395788		329
	0.180163	0.0745647		271
Phen-mCF_3-Ph	0.176331	0.0675948		290
	0.159286	0.0410187		340
Phen-pCF_3-Ph	0.171973	0.0610895		271
	0.160165	0.0393145		321

Table S5. The CIE color coordinates calculated results from the PL emission spectra of the Eu(III) complexes in solid form at different excitation source.

SOLID				
Compounds	**x**	**y**	**colour**	**Excitation wavelength (nm)**
$Eu(TTA)_3$Phen-Ph-Ph	0.639333	0.341546		270

	0.644392	0.348862		360
Eu(TTA)$_3$Phen-mCF$_3$-Ph	0.632984	0.342448		270
	0.648876	0.34382		360
Eu(TTA)$_3$Phen-pCF$_3$-Ph	0.589598	0.34419		270
	0.642717	0.342321		360

Table S6. The CIE color coordinates calculated results from the PL emission spectra of the ligands in solid form at different excitation source.

Solution				
Compounds	**x**	**y**		**Excitation wavelength (nm)**
Phen-Ph-Ph	0.166401	0.175981		339
	0.165785	0.179578		380
Phen-mCF$_3$-Ph	0.162099	0.135490		349
	0.162286	0.1360187		380
Phen-pCF$_3$-Ph	0.151671	0.112979		353
	0.156015	0.113045		380

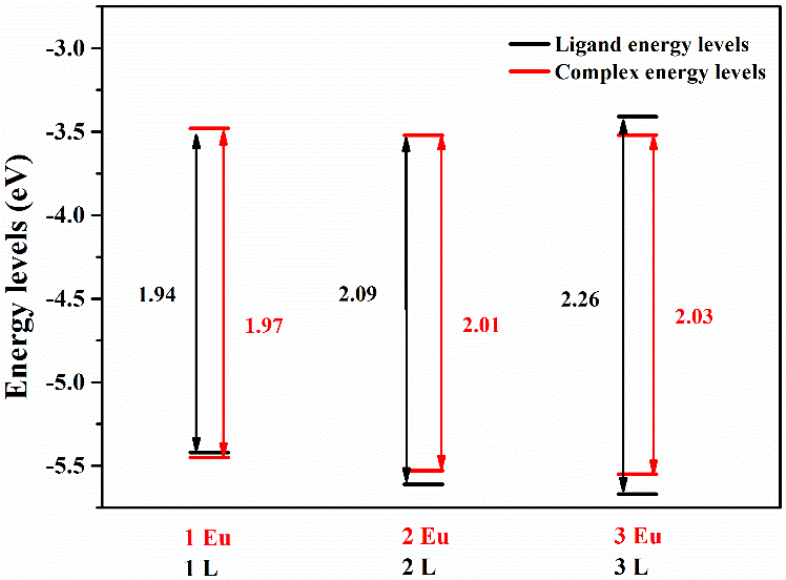


Fig. S14 The energy levels of the complex and corresponding ligands.

Table S7. The HOMO-LUMO and singlet triplet calculations of the ligands.

LIGANDS	**HOMO** (eV)	**LUMO** (eV)	**Band gap** (eV)	**S1** (eV)		**T1** (eV)	
				gas	dcm	gas	dcm
Phen-Ph-Ph	5.742	1.516	4.226	3.488	3.613	2.774	2.807
Phen-mCF_3-Ph	5.894	1.877	4.017	3.510	3.629	2.768	2.803
Phen-pCF_3-Ph	5.918	1.901	4.017	3.489	3.638	2.767	2.804

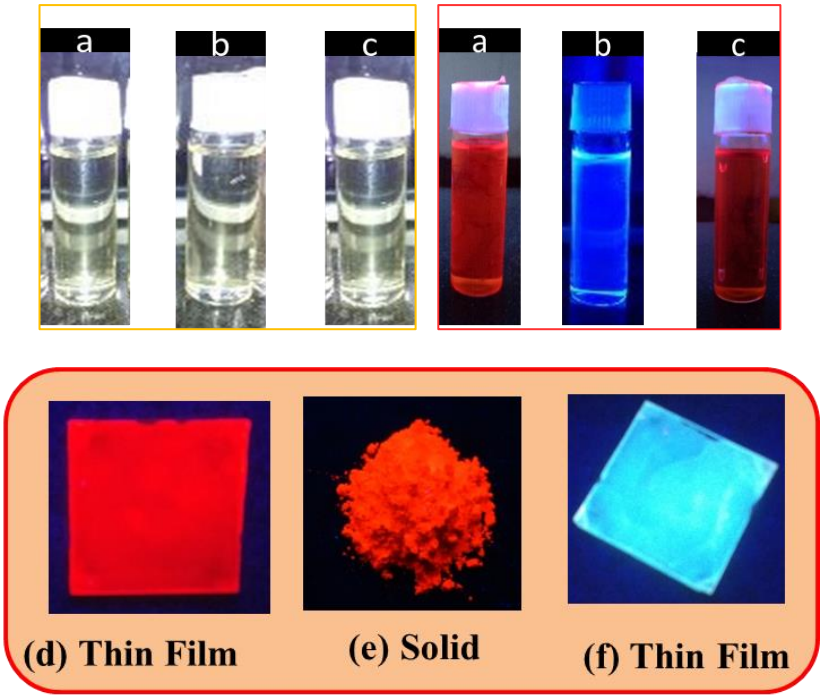
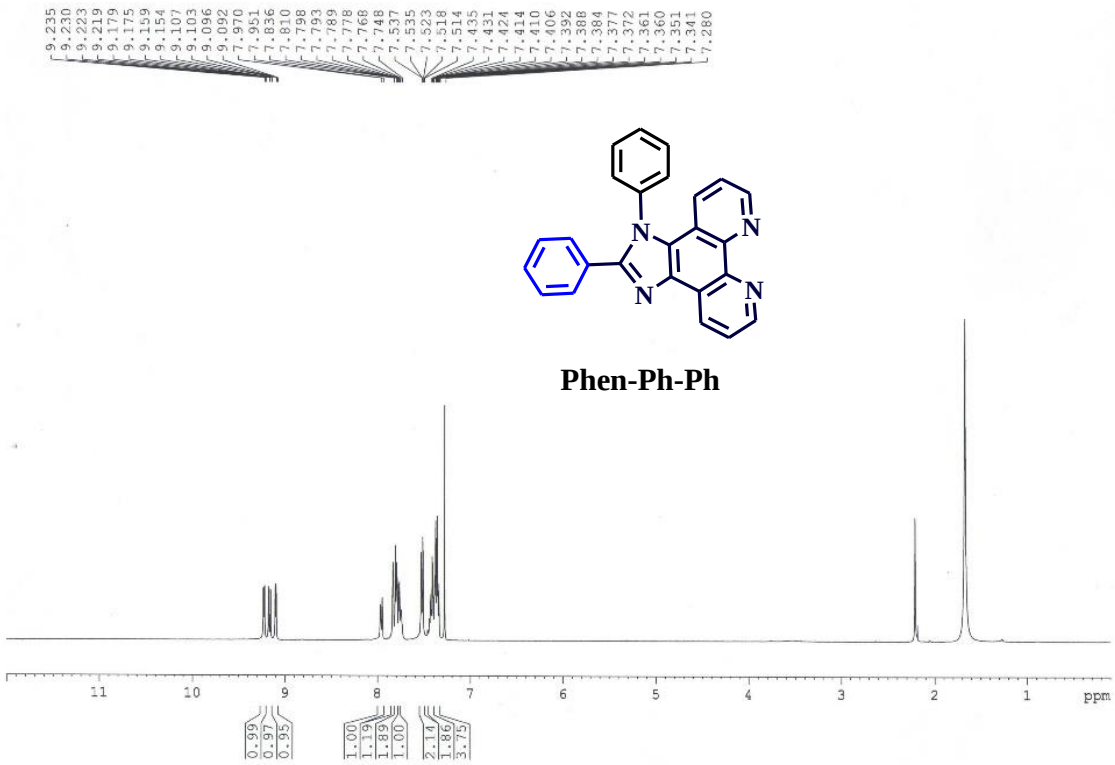


Fig. S15. Synthesised Eu(III) complex, ligand and Eu $(TTA)_3$ under normal light, a, b, c (left) and under UV lamp (right) in solution a, b, c; respectively. Thin film of (d) $Eu(TTA)_3$Phen-R-Ph (3 complexes), solid of (e) Phen-R-Ph (3 ligands) and thin film of (f) ligands.



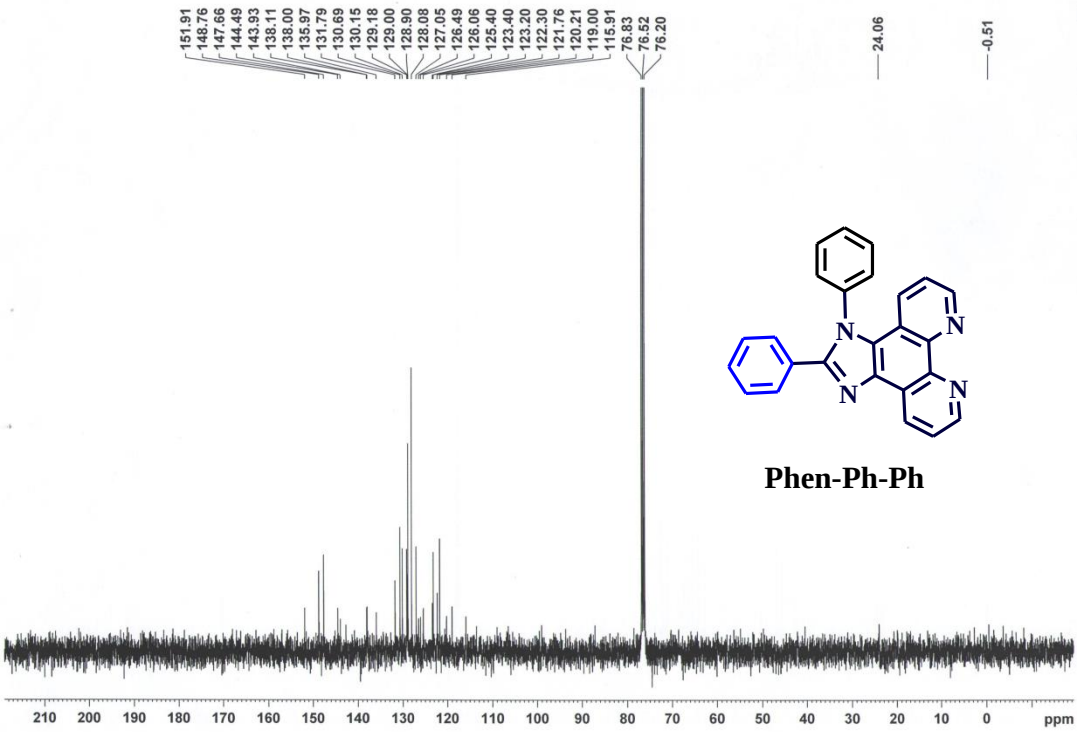


Fig. S16 The ^{1}H (top) and ^{13}C (bottom) NMR of the 1L ligand.

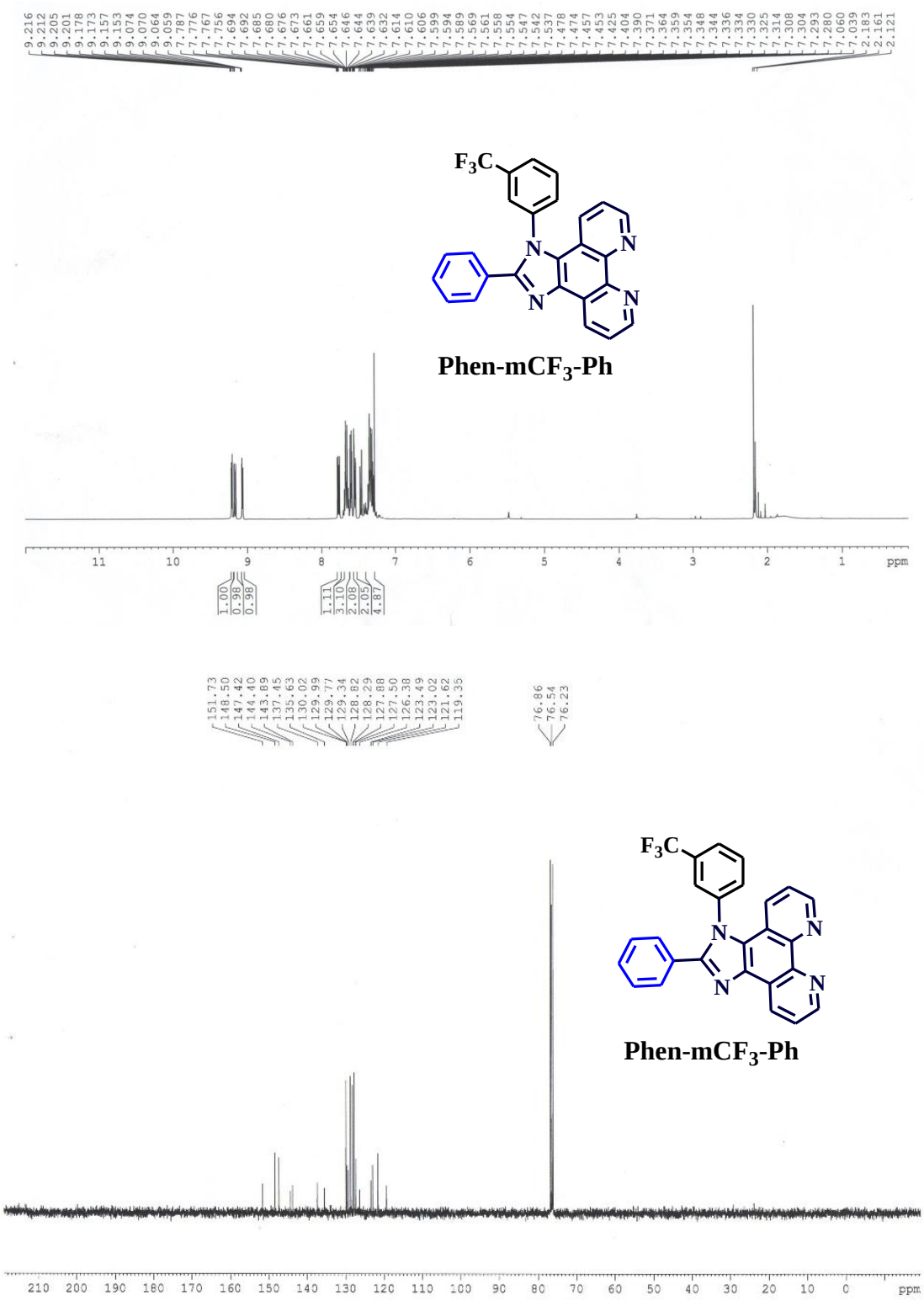


Fig. S17 The ^{1}H (top) and ^{13}C (bottom) NMR of the 2L ligand.

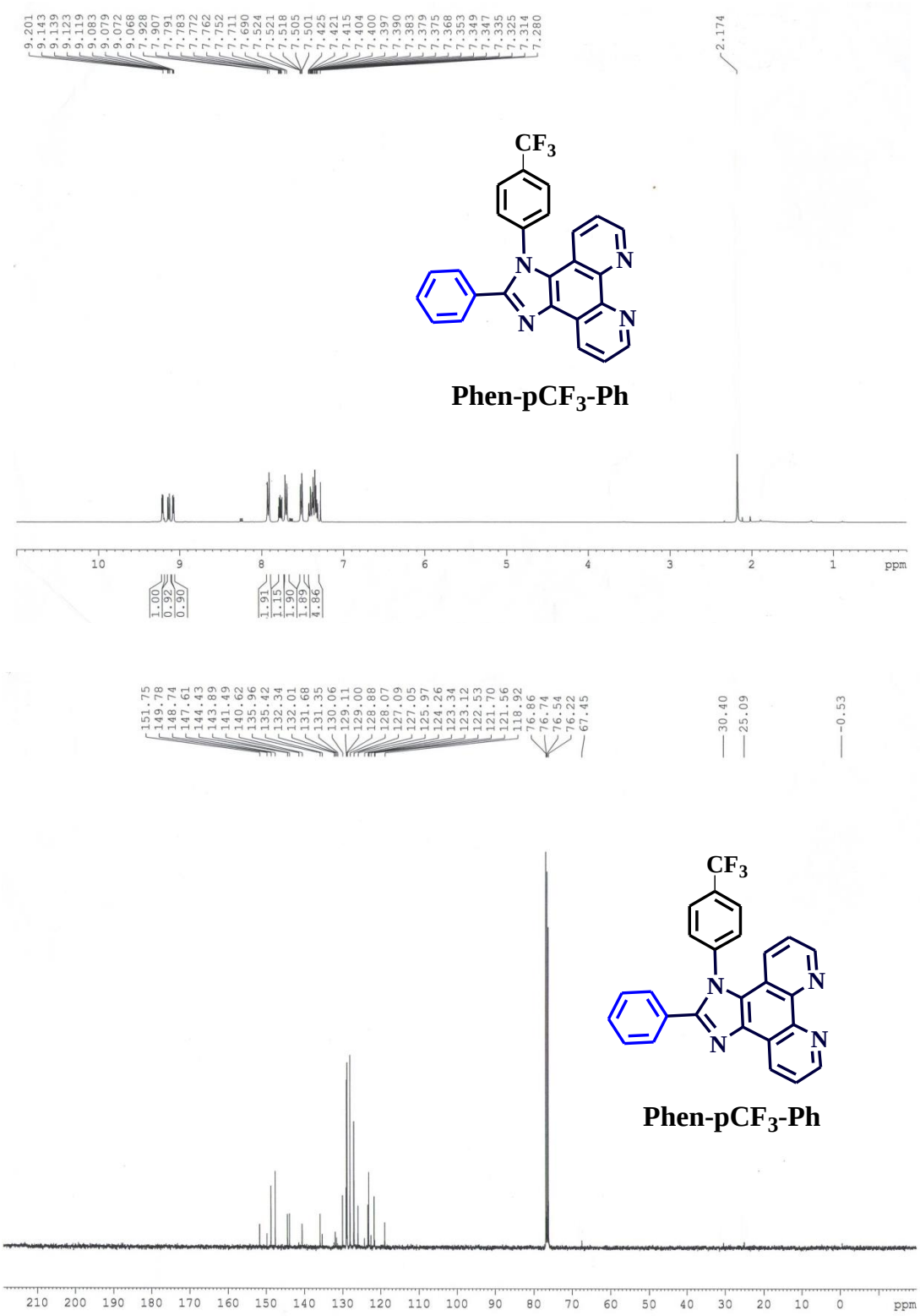


Fig. S18 The ^{1}H (top) and ^{13}C (bottom) NMR of the 3L ligand.

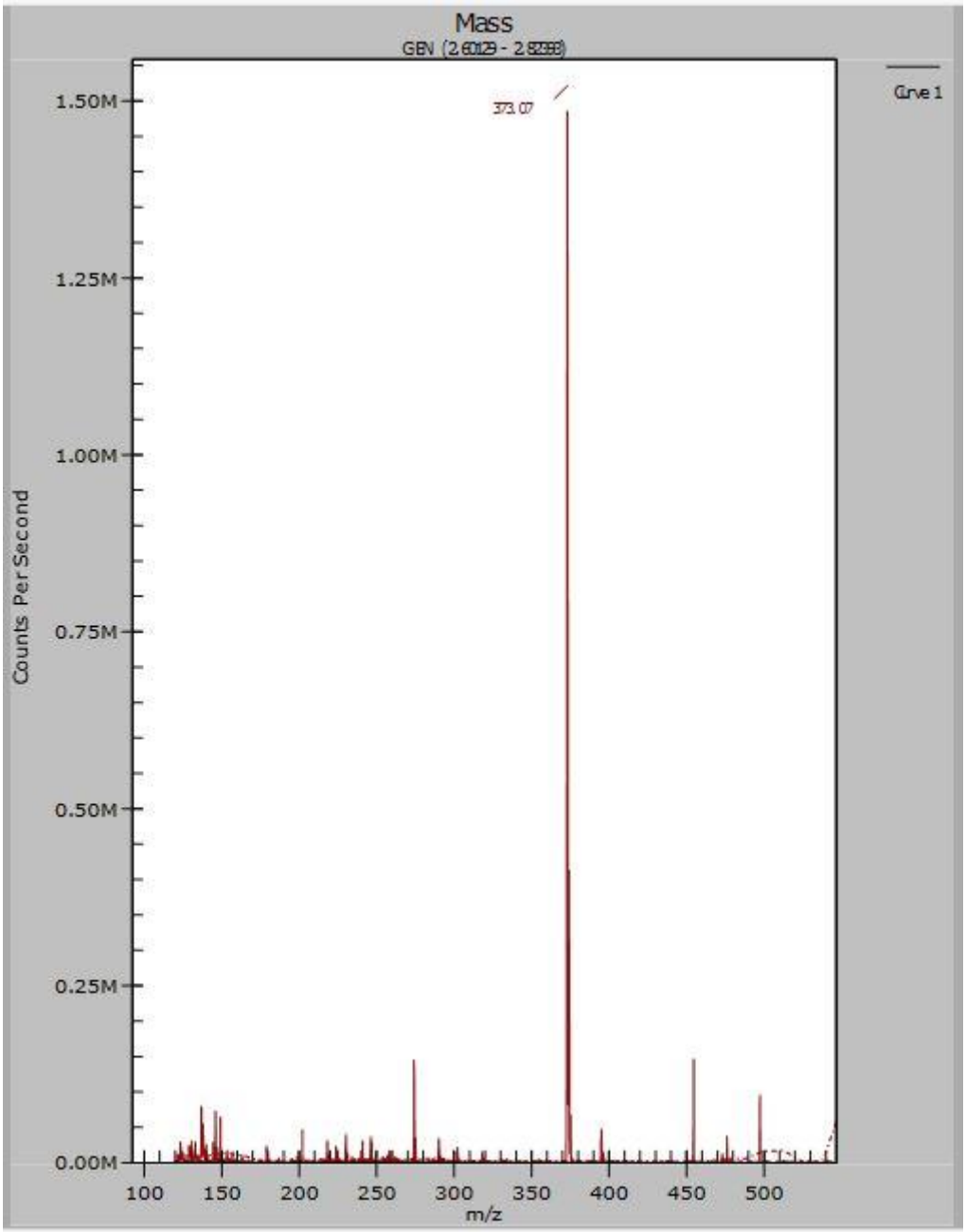


Fig. S19 The mass spectrum of the 1L ligand.

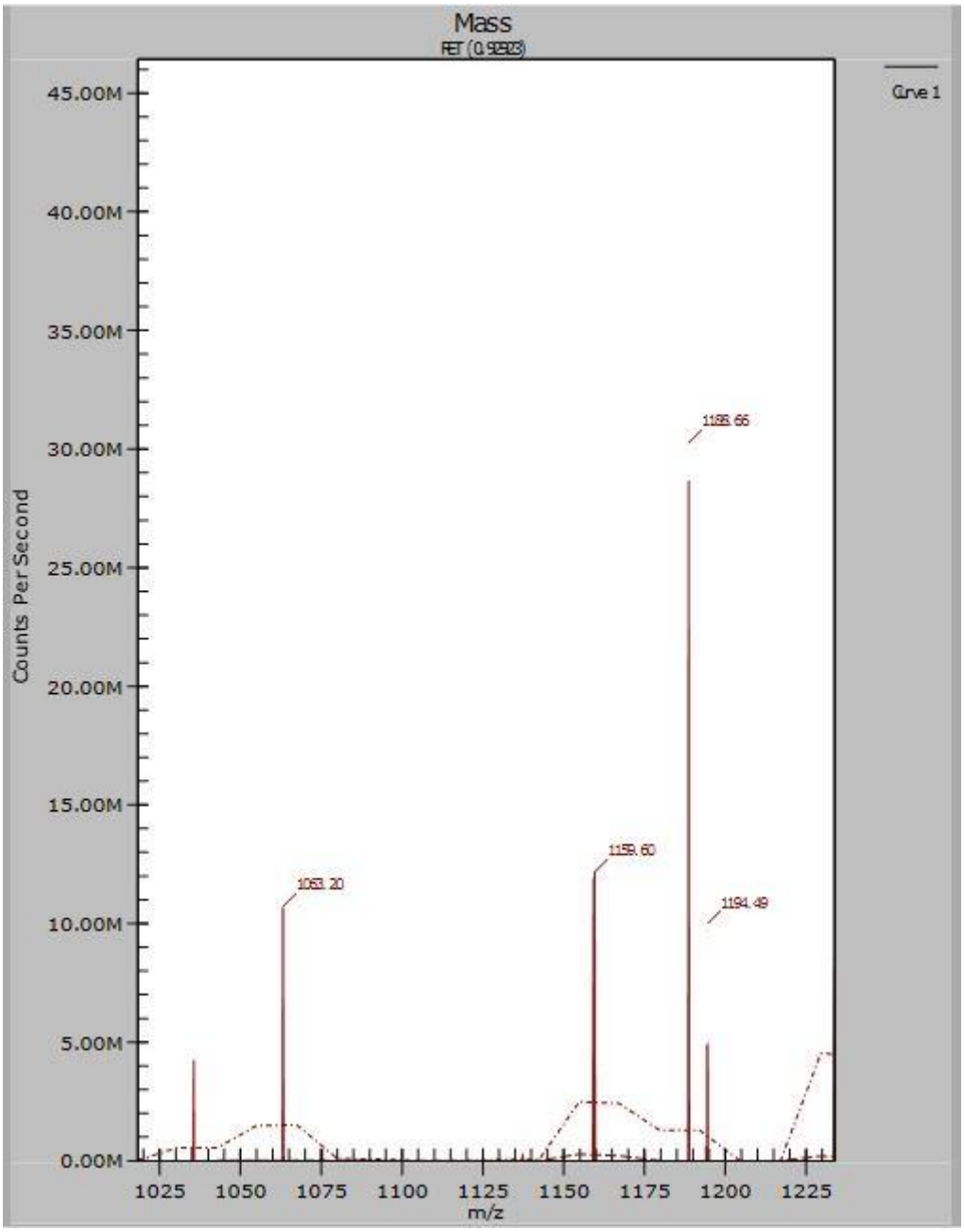


Fig. S20 The mass spectrum of the 1Eu complex.

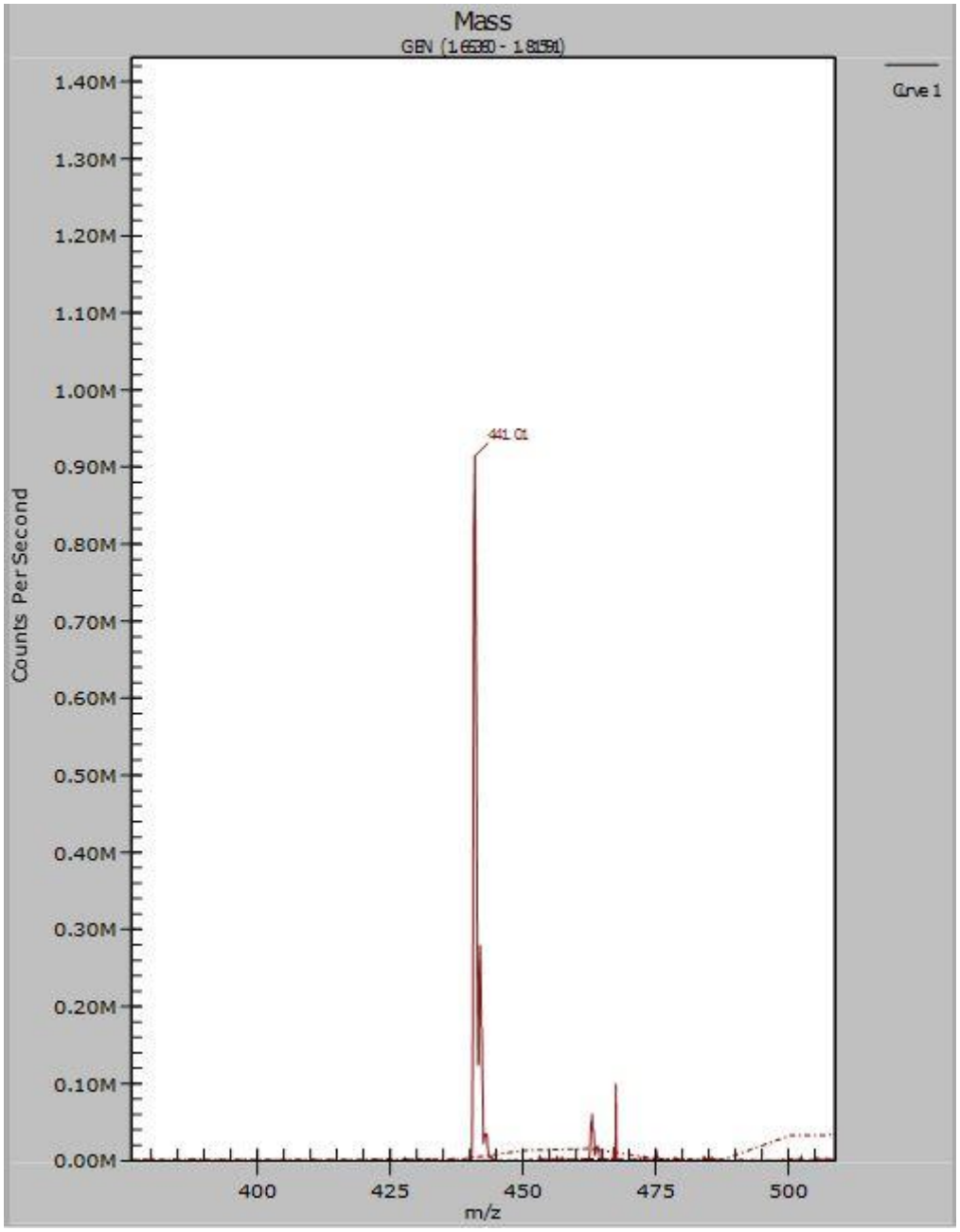


Fig. S21 The mass spectrum of the 2L ligand.

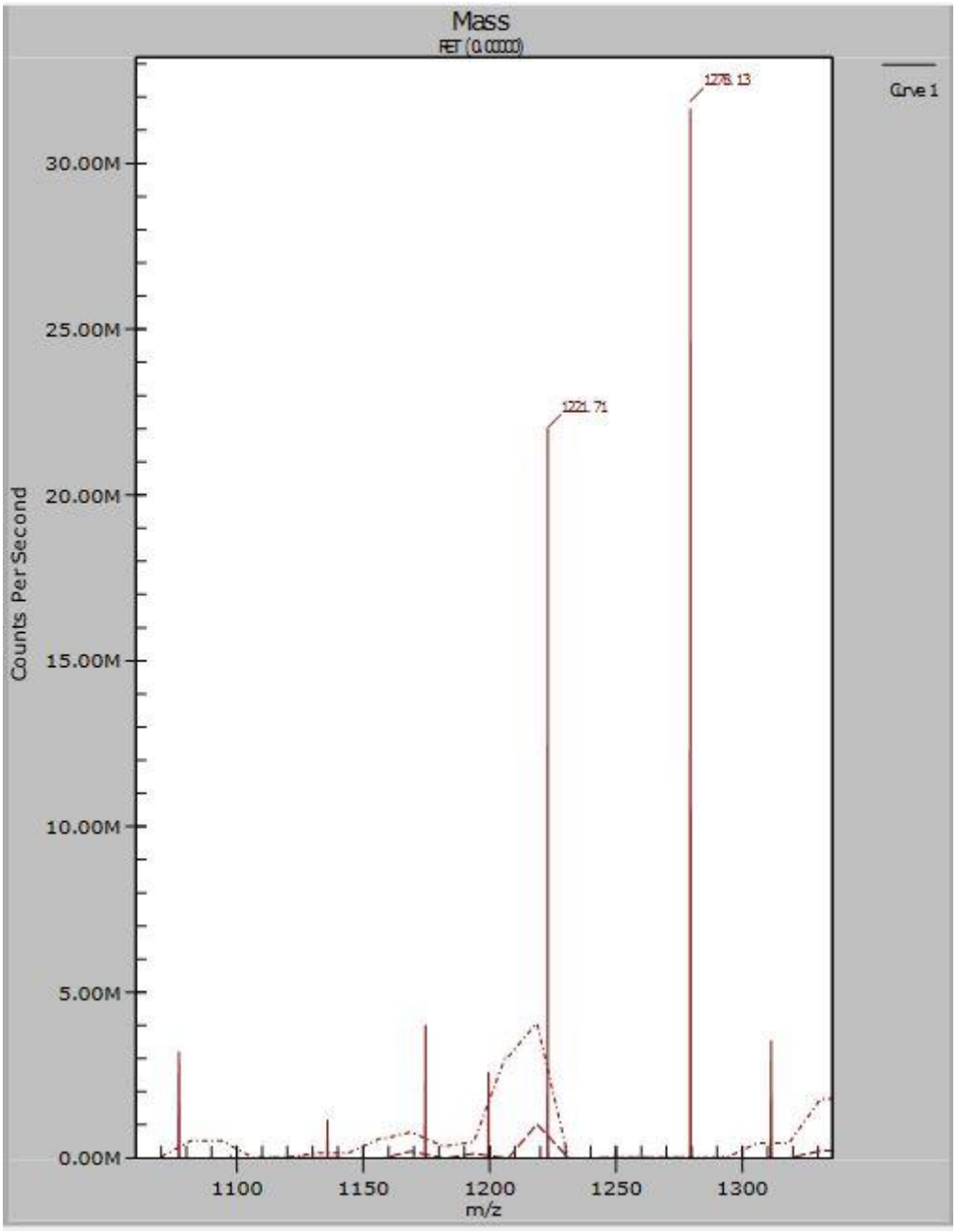


Fig. S22 The mass spectrum of the 2Eu complex.

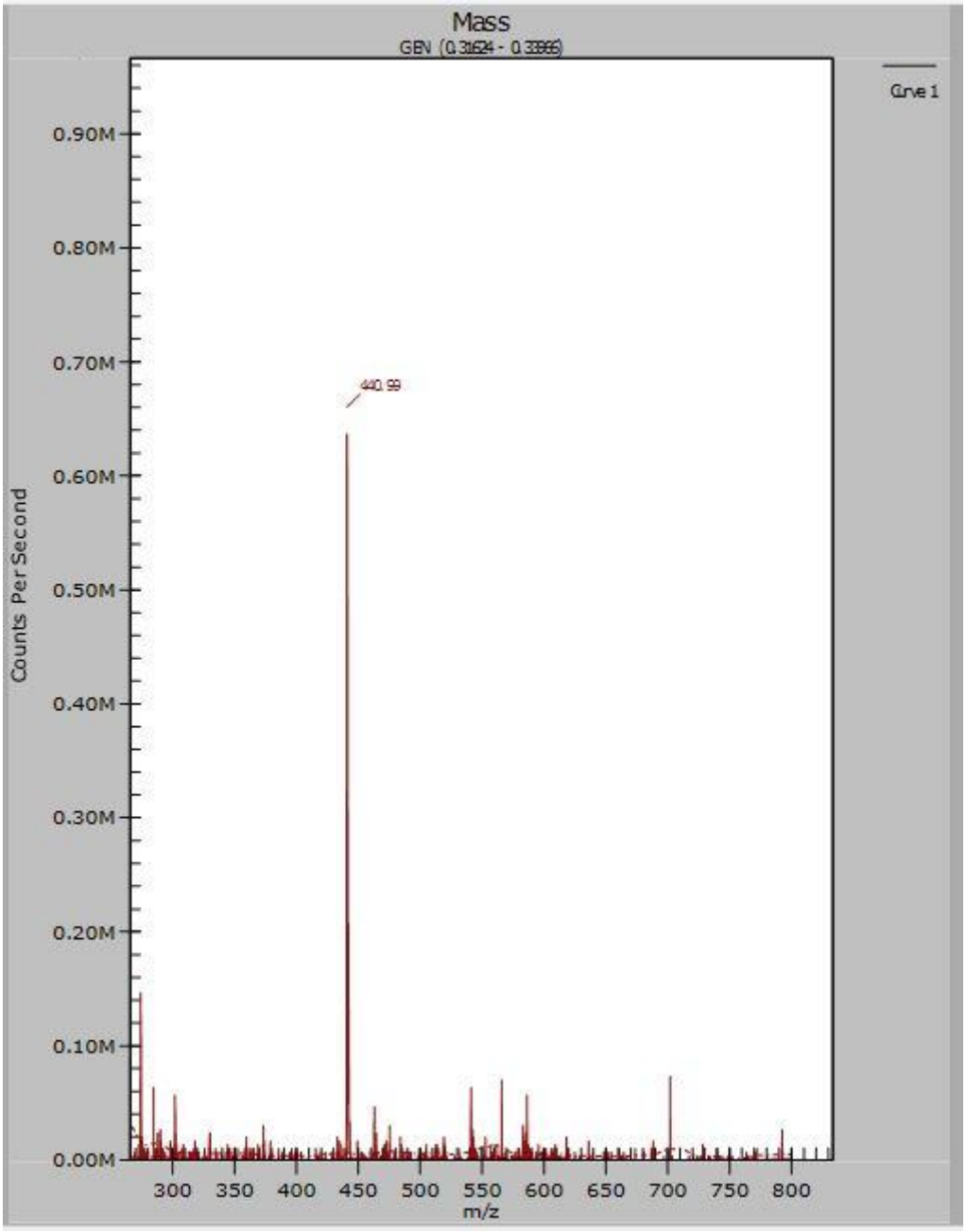


Fig. S23 The mass spectrum of the 3L ligand.

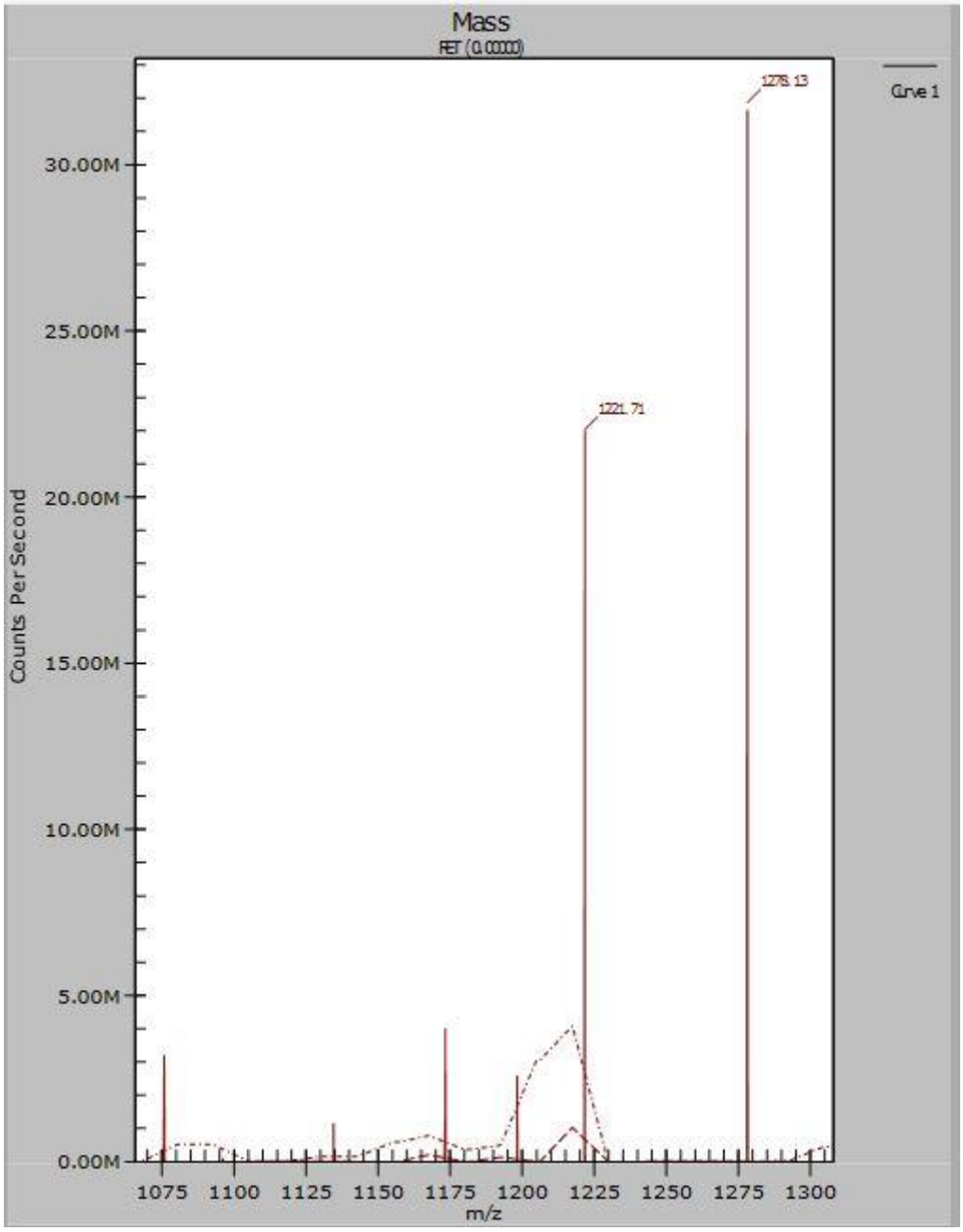


Fig. S24 The mass spectrum of the 3Eu complex.

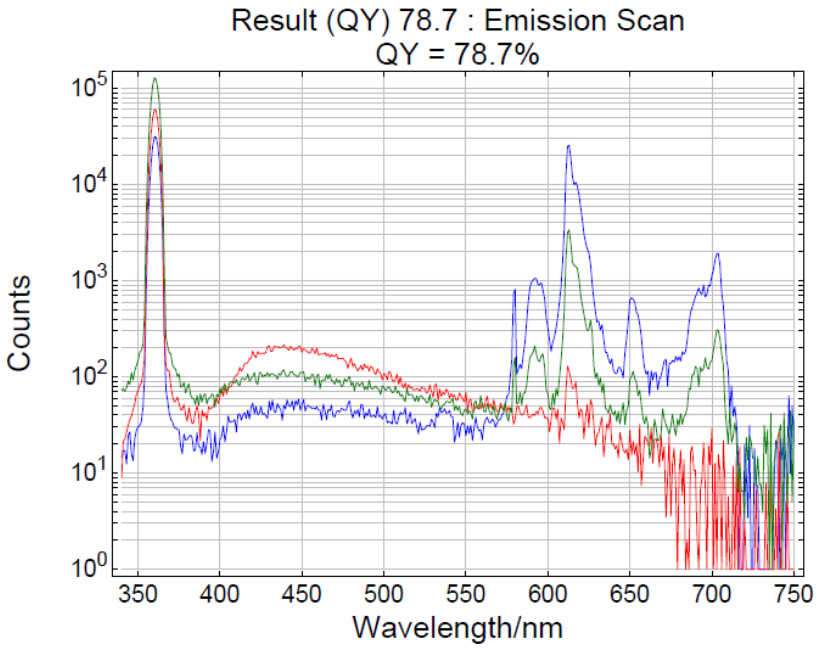


Fig. S25 The PLQY of the thin film of the complex, Eu(TTT)$_3$Phen-pCF$_3$-Ph. Red-reference, Blue-direct and Green-indirect.

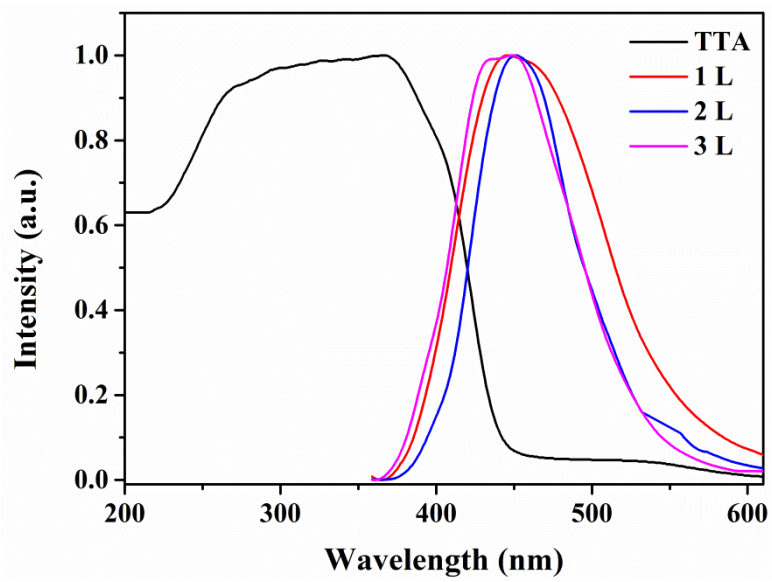


Fig. S26 The emission spectrum of ligands, 1L, 2L and 3L and UV-vis absorption spectra of the TTA at room-temperature.

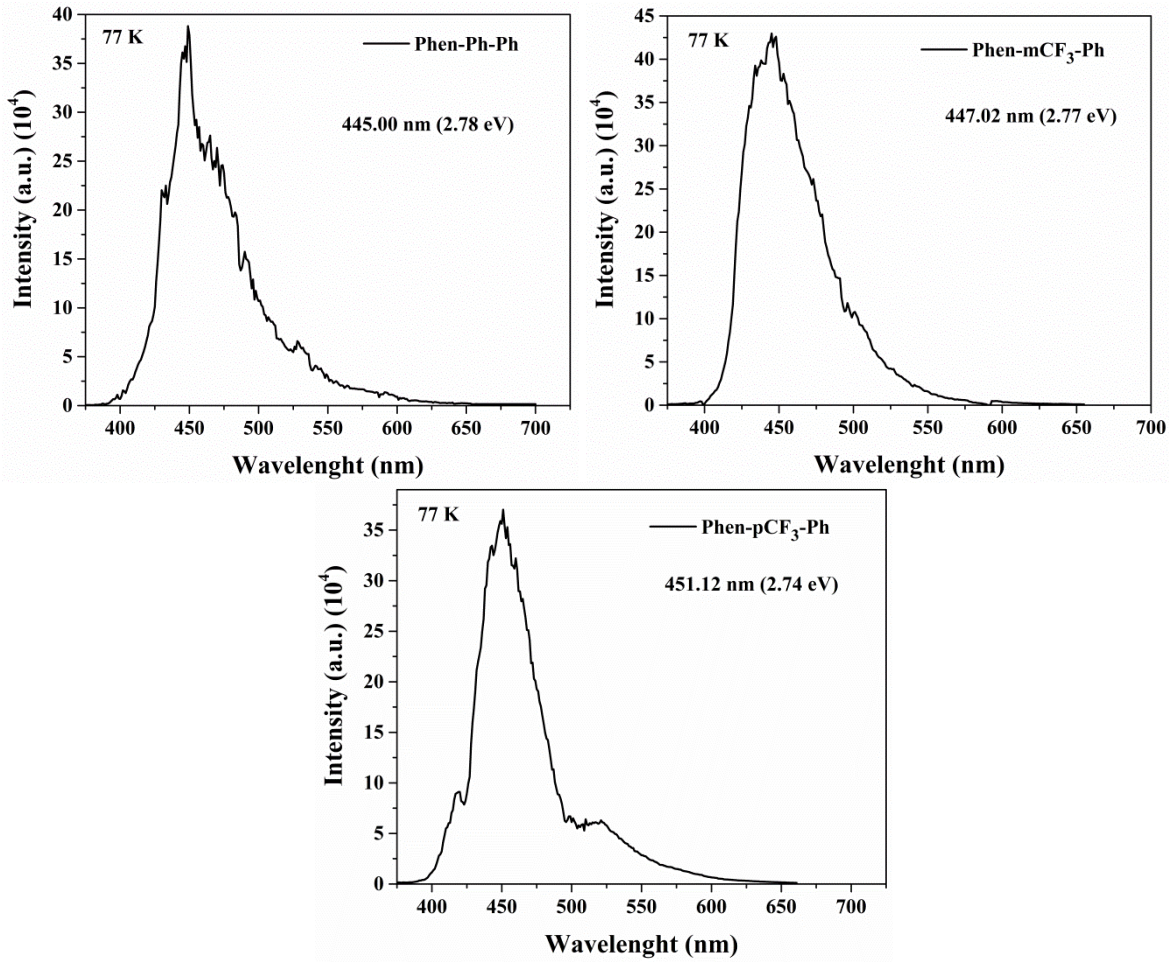


Fig. S27 The phosphorescence emission spectrum of ligands, Gd(III) complex with 1L, 2L and 3L at 77 K.

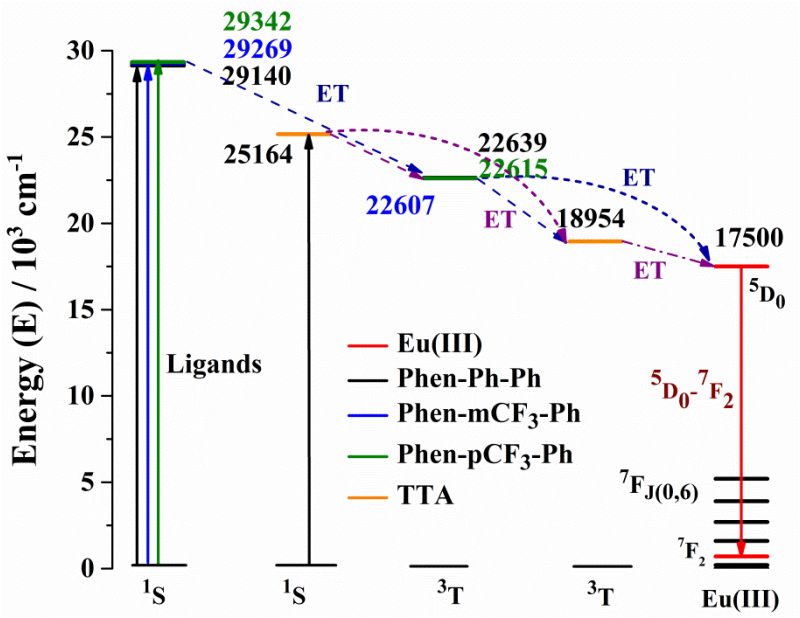


Fig. S28 The schematic diagram of the energy transfer process in the Eu(III) complex to rach Eu(III) metal ion via ligand and TTA levels.

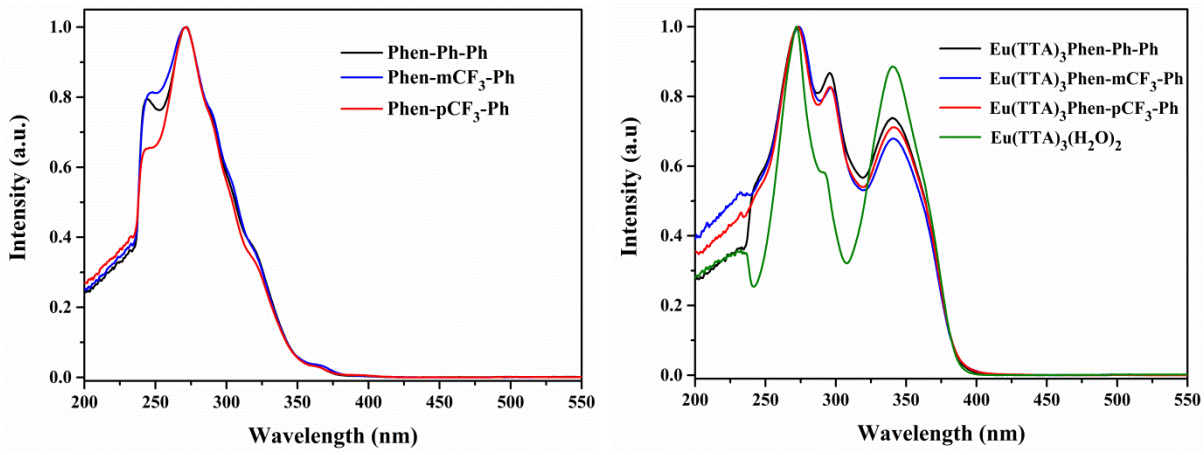


Fig. S29 The UV-absorption spectra of the ligands (left) and corresponding Eu^{III} complexes (right).

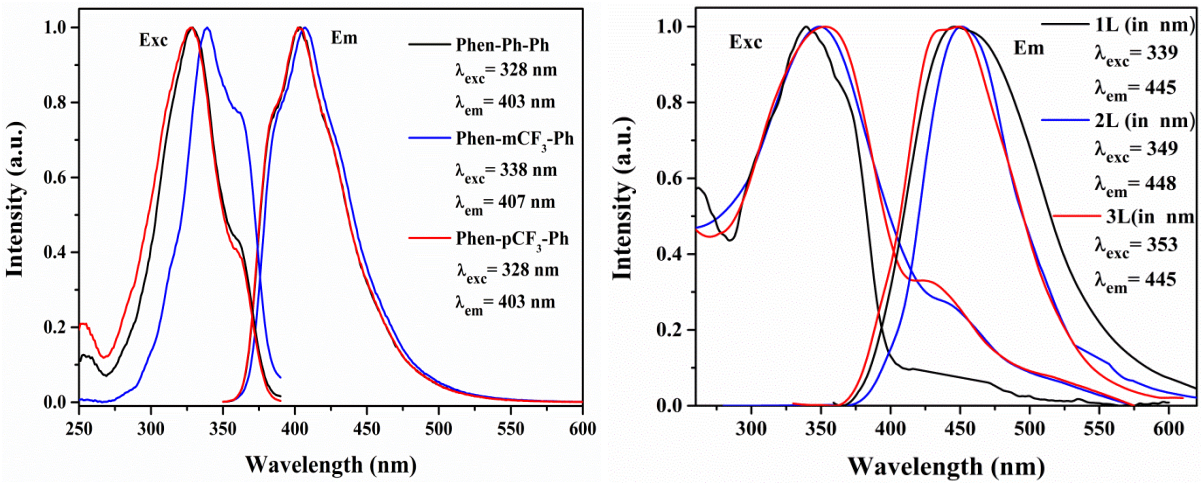


Fig. S30 The PL excitation and emission spectra of ligands, 1L, 2Land 3L in solution (left) and solid form (right).

Table S8. The calculated experimental branching ratios (β_{1-3}) of the complexes.

S. No.	Compound	β_1	β_2	β_3
1.	**1Eu, Solution**	6.68	88.30	4.83
2.	**Solid**	12.52	80.47	7.27
3.	**Thin film, 0.1%**	15.93	72.47	11.58
4.	**0.5 %**	14.32	76.05	9.61
5.	**1 %**	19.41	69.9	10.68
6.	**5 %**	25.1	61.09	13.80

7.	**2Eu, Solution**	5.62	90.45	3.91
8.	**Solid**	8.21	85.37	6.41
9.	**Thin film, 0.1%**	15.47	73.47	11.05
10	**0.5 %**	19.09	70.19	10.70
11.	**1 %**	19.16	68.58	12.25
12.	**5 %**	23.67	65.80	13.52
13.	**3Eu, Solution**	6.16	89.49	4.33
14.	**Solid**	5.86	88.30	5.83
15.	**Thin film, 0.1%**	14.23	72.06	13.70
16.	**0.5 %**	22.21	67.22	10.56
17.	**1 %**	15.71	70.01	14.26
18.	**5 %**	24.21	62.26	13.51

Table S9. xyz coordinates of the optimized ligand, 1L (Phen-Ph-Ph).

	x	**y**	**z**
6	-4.563876000	-5.523402000	-1.907758000
6	-3.322485000	-6.063372000	-2.181513000
6	-2.216521000	-5.207561000	-2.380833000
6	-2.458175000	-3.794574000	-2.307458000
6	-4.687934000	-4.126725000	-1.836677000
6	-0.869748000	-5.619318000	-2.672103000
6	-1.373358000	-2.829741000	-2.545718000
6	-0.070527000	-3.293912000	-2.866825000
6	0.149924000	-4.709301000	-2.929232000
6	0.944358000	-2.348160000	-3.104629000
1	1.942181000	-2.696939000	-3.349672000
6	0.635061000	-1.005887000	-3.014215000
6	-0.685919000	-0.643765000	-2.686035000
1	-5.427772000	-6.162055000	-1.752546000
1	-3.203454000	-7.136400000	-2.247170000
1	-5.653092000	-3.672738000	-1.615678000
1	1.384593000	-0.240124000	-3.188021000
1	-0.954675000	0.408946000	-2.606005000
7	-3.679190000	-3.291948000	-2.032839000
7	-1.660226000	-1.512043000	-2.459048000
7	1.323754000	-5.347607000	-3.224957000
7	-0.270538000	-6.873861000	-2.807514000
6	1.063066000	-6.640509000	-3.149538000

6	2.085025000	-7.666493000	-3.423329000
6	2.102435000	-8.943751000	-2.838384000
6	3.132530000	-7.310124000	-4.293425000
6	3.130008000	-9.840183000	-3.130590000
1	1.329967000	-9.238782000	-2.139894000
6	4.154999000	-8.208468000	-4.580080000
1	3.126543000	-6.317897000	-4.729845000
6	4.156591000	-9.480916000	-4.003482000
1	3.129408000	-10.821215000	-2.664633000
1	4.952119000	-7.915722000	-5.257168000
1	4.953720000	-10.183209000	-4.228726000
6	-0.921133000	-8.145976000	-2.688662000
6	-1.270390000	-8.857394000	-3.838393000
6	-1.205280000	-8.663002000	-1.420360000
6	-1.905634000	-10.093892000	-3.716734000
1	-1.043212000	-8.439258000	-4.813314000
6	-1.845968000	-9.896570000	-1.306867000
1	-0.926240000	-8.094640000	-0.538909000
6	-2.195427000	-10.613546000	-2.453994000
1	-2.176269000	-10.648358000	-4.609894000
1	-2.069134000	-10.298000000	-0.323194000
1	-2.691862000	-11.574742000	-2.363072000

Table S10. xyz coordinates of the optimized ligand, 2L (Phen-mCF_3-Ph).

	x	y	z
6	-4.597324000	-5.415495000	-1.904137000
6	-3.368295000	-5.975839000	-2.191866000
6	-2.243136000	-5.141098000	-2.371250000
6	-2.453490000	-3.724960000	-2.265782000
6	-4.689814000	-4.018449000	-1.799138000
6	-0.905819000	-5.574954000	-2.673344000
6	-1.348822000	-2.778829000	-2.486293000
6	-0.057768000	-3.263784000	-2.822918000
6	0.131689000	-4.681945000	-2.916088000
6	0.976651000	-2.335508000	-3.044913000
1	1.965742000	-2.700106000	-3.301943000
6	0.696827000	-0.989272000	-2.924098000
6	-0.614724000	-0.605894000	-2.582057000
1	-5.475371000	-6.038197000	-1.764875000
1	-3.275492000	-7.049471000	-2.285047000
1	-5.644190000	-3.548324000	-1.565934000
1	1.461996000	-0.236314000	-3.084802000
1	-0.860212000	0.450314000	-2.477959000
7	-3.662725000	-3.202367000	-1.977398000
7	-1.606758000	-1.457542000	-2.369583000
7	1.291581000	-5.337825000	-3.231158000

7	-0.331669000	-6.839377000	-2.838734000
6	1.006417000	-6.625296000	-3.182601000
6	2.003491000	-7.668697000	-3.479823000
6	2.012648000	-8.942981000	-2.888512000
6	3.034365000	-7.334241000	-4.377442000
6	3.014995000	-9.859988000	-3.202861000
1	1.254877000	-9.219374000	-2.166156000
6	4.032180000	-8.252985000	-4.686142000
1	3.035377000	-6.344002000	-4.818527000
6	4.024322000	-9.522952000	-4.104344000
1	3.008833000	-10.838969000	-2.732928000
1	4.816622000	-7.978421000	-5.385136000
1	4.801420000	-10.241253000	-4.347899000
6	-1.000362000	-8.101109000	-2.745921000
6	-1.329331000	-8.796959000	-3.909350000
6	-1.320541000	-8.628506000	-1.490255000
6	-1.979591000	-10.028496000	-3.810803000
1	-1.085238000	-8.376447000	-4.877796000
6	-1.977940000	-9.854837000	-1.402639000
1	-1.056519000	-8.071495000	-0.597224000
6	-2.307521000	-10.558912000	-2.560994000
1	-2.232787000	-10.262631000	-0.429873000
1	-2.822760000	-11.510842000	-2.498786000
6	-2.283218000	-10.813548000	-5.061744000
9	-2.475726000	-10.005409000	-6.125170000
9	-3.391487000	-11.571793000	-4.915893000
9	-1.269776000	-11.650731000	-5.376142000

Table S11. xyz coordinates of the optimized ligand, 3L (Phen-pCF_3-Ph).

	x	**y**	**z**
6	-4.584307000	-5.501844000	-1.955463000
6	-3.345176000	-6.045336000	-2.231788000
6	-2.229355000	-5.195596000	-2.397727000
6	-2.458922000	-3.782694000	-2.290890000
6	-4.695964000	-4.106344000	-1.848170000
6	-0.883458000	-5.611564000	-2.686770000
6	-1.364118000	-2.821945000	-2.496858000
6	-0.063736000	-3.289217000	-2.822157000
6	0.144785000	-4.704622000	-2.917636000
6	0.961162000	-2.347150000	-3.029834000
1	1.957464000	-2.698188000	-3.277818000
6	0.663361000	-1.005053000	-2.906221000
6	-0.656321000	-0.639588000	-2.576038000
1	-5.455308000	-6.136424000	-1.826107000
1	-3.237255000	-7.117511000	-2.325518000
1	-5.658657000	-3.649222000	-1.623583000
1	1.420736000	-0.241965000	-3.055601000

1	-0.916010000	0.413004000	-2.469838000
7	-3.677731000	-3.276524000	-2.013870000
7	-1.639791000	-1.504440000	-2.377504000
7	1.316361000	-5.344866000	-3.222161000
7	-0.291286000	-6.868186000	-2.848620000
6	1.047387000	-6.635807000	-3.178188000
6	2.061364000	-7.666790000	-3.461216000
6	2.085814000	-8.933947000	-2.855391000
6	3.092550000	-7.326477000	-4.356057000
6	3.103527000	-9.839346000	-3.153600000
1	1.328073000	-9.212361000	-2.133653000
6	4.105736000	-8.233698000	-4.648959000
1	3.082299000	-6.340674000	-4.806999000
6	4.113154000	-9.497144000	-4.053001000
1	3.109800000	-10.812564000	-2.671800000
1	4.890777000	-7.954940000	-5.345622000
1	4.902869000	-10.206110000	-4.283037000
6	-0.942870000	-8.139574000	-2.768205000
6	-1.229879000	-8.849123000	-3.936193000
6	-1.279837000	-8.669866000	-1.517663000
6	-1.854358000	-10.092378000	-3.854764000
1	-0.959567000	-8.426990000	-4.897803000
6	-1.908820000	-9.908942000	-1.439196000
1	-1.045060000	-8.108973000	-0.619186000
6	-2.195025000	-10.621145000	-2.608246000
1	-2.072669000	-10.652210000	-4.757021000
1	-2.166425000	-10.329460000	-0.473456000
6	-2.922907000	-11.937274000	-2.516344000
9	-4.262290000	-11.757477000	-2.459372000
9	-2.673245000	-12.726050000	-3.582677000
9	-2.570442000	-12.622624000	-1.406858000

Table S12. Bi-exponential fitting curve parameters in solution and solid for the complexes and ligands.

S. No.	**Compound**	**Solid/ Solution**	**A1**	**A2**	**T1**	**T2**
1	1Eu	Solid	3897.12376	2523.31179	0.38209	0.73093
2	2Eu	Solid	3388.07056	3830.24044	0.19847	0.55168
3	3Eu	solid	3818.41038	3859.62712	0.1879	0.50075
4	1L	Solid	828.371505	845212.0812	0.1527	0.0019
		Acetone	418553.8446	941.26647	0.00215	0.01576
		$CHCl_3$	925.77607	6611175.55292	0.01443	0.00195

		DCM	606.5647	1038660	0.01606	0.00179
		DMF	846.37997	234640.1114	0.01672	0.00243
		DMSO	687.62912	273750.56519	0.01805	0.00234
		THF	627.96825	1381660	0.01493	0.0017
		Toluene	Mono exponential			
5	2L	Solid	1169540	701.25643	0.00179	0.01488
		Acetone	636.32394	1273730	0.01538	0.00172
		$CHCl_3$	77413940063	916.04381	0.00189	0.01416
		DCM	703890.30721	819.46402	0.00193	0.01517
		DMF	899399.69266	816.79378	0.00183	0.01469
		DMSO	1347.61517	111952.39694	0.0165	0.00297
		THF	Mono exponential			
		Toluene	340322.0774	710.35914	0.00222	0.01687
6	3L	Solid	1222.84932	1732972	0.01328	0.00168
		Acetone	946.26701	546614.06202	0.0152	0.00202
		$CHCl_3$	958433.1508	790.36524	0.00181	0.0145
		DCM	1041.00029	438619.39234	0.01509	0.00212
		DMF	785423.2324	803.88185	0.00188	0.01519
		DMSO	786.66562	763030.33394	0.01526	0.00189
		THF	1001070	733.84706	0.0018	0.01498
		Toluene	603223.4113	835.85078	0.00198	0.01542

Table S13. Absorption, excitation and emission of the ligands and the corresponding complexes in solution as well as solid.

S. No.	Compound	λ_{abs} (nm)[a,b]	λ_{ex} (nm)[a,c]		λ_{em} (nm)[a,d]	I_2/I_1 (a/e)	FWHM (a/e)
		solution		solid			
1.	**Phen-Ph-Ph**	244, 271, 317	328, 360	339	403, 445[e]	NA	NA
2.	**Phen-mCF$_3$-Ph**	246, 271, 317	338, 360	349	407, 448[e]	NA	NA
3.	**Phen-pCF$_3$-Ph**	243, 271, 316	328, 357	353	403, 445[e]	NA	NA
4.	**Eu(TTA)$_3$Phen-Ph-Ph**	296, 340, 342	251, 286, 319, 372	275, 319, 363	612	12.5/ 6.4	7.3/ 10.6
5.	**Eu(TTA)$_3$Phen-mCF$_3$-Ph**	296, 340, 272	253, 287, 320, 370	287, 319, 367	612	13.9/ 10.6	5.9/ 8.0
6.	**Eu(TTA)$_3$Phen-pCF$_3$-Ph**	296, 341, 272	248, 286, 319, 372	321, 375	612	15.2/ 15.7	6.0/ 4.9

[a] measured in chloroform solution at 298 K, [b]absorption peaks from the UV-Vis absorption spectra. [c]excitation peaks from Pl monitoring emission. [d]emission peaks from PL emission spectra. [e]emission from PL in solid form. NA = Not applicable