wwPDB X-ray Structure Validation Summary Report (i)

Jun 16, 2024 – 10:39 AM EDT

PDB ID	:	5EAI
Title	:	Crystal Structure of NAD(P)H dehydrogenase, quinone 1 complexed with a chemotherapeutic naphthoquinone E6a
Authors	:	Pidugu, L.S.; Mbimba, J.E.; Ahmad, M.; Pozharski, E.; Sausville, E.A.; Emadi, A.; Toth, E.A.
Deposited on	:	2015-10-16
Resolution	:	2.90 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at *validation@mail.wwpdb.org*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

The following versions of software and data (see references (i)) were used in the production of this report:

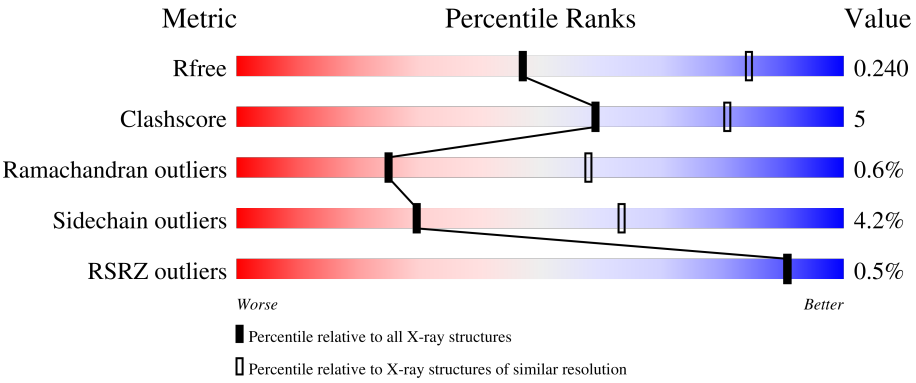
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.37.1
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.37.1

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.90 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	1957 (2.90-2.90)
Clashscore	141614	2172 (2.90-2.90)
Ramachandran outliers	138981	2115 (2.90-2.90)
Sidechain outliers	138945	2117 (2.90-2.90)
RSRZ outliers	127900	1906 (2.90-2.90)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	277	86% 11%
1	B	277	88% 8%
1	C	277	86% 11%
1	D	277	85% 11%

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Mol	Chain	Length	Quality of chain
1	E	277	82% 13%
1	F	277	86% 10%
1	G	277	81% 14%
1	H	277	87% 10%
1	I	277	81% 16%
1	J	277	84% 13%
1	K	277	83% 13%
1	L	277	86% 10%
1	M	277	85% 12%
1	N	277	83% 13%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 31021 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called NAD(P)H dehydrogenase [quinone] 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	270	Total	C	N	O	S	46	0	0
			2134	1386	356	385	7			
1	B	270	Total	C	N	O	S	78	0	0
			2122	1379	353	383	7			
1	C	272	Total	C	N	O	S	61	0	0
			2161	1405	362	387	7			
1	D	271	Total	C	N	O	S	45	0	0
			2164	1407	363	387	7			
1	E	271	Total	C	N	O	S	55	0	0
			2155	1402	361	385	7			
1	F	271	Total	C	N	O	S	63	0	0
			2152	1400	359	386	7			
1	G	272	Total	C	N	O	S	78	0	0
			2139	1389	362	381	7			
1	H	271	Total	C	N	O	S	77	0	0
			2158	1403	362	386	7			
1	I	272	Total	C	N	O	S	31	0	0
			2163	1406	363	387	7			
1	J	271	Total	C	N	O	S	62	0	0
			2148	1396	361	384	7			
1	K	271	Total	C	N	O	S	69	0	0
			2154	1401	361	385	7			
1	L	273	Total	C	N	O	S	69	0	0
			2164	1406	364	387	7			
1	M	273	Total	C	N	O	S	80	0	0
			2151	1398	360	386	7			
1	N	271	Total	C	N	O	S	53	0	0
			2134	1391	351	385	7			

There are 42 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-3	GLY	-	expression tag	UNP P15559

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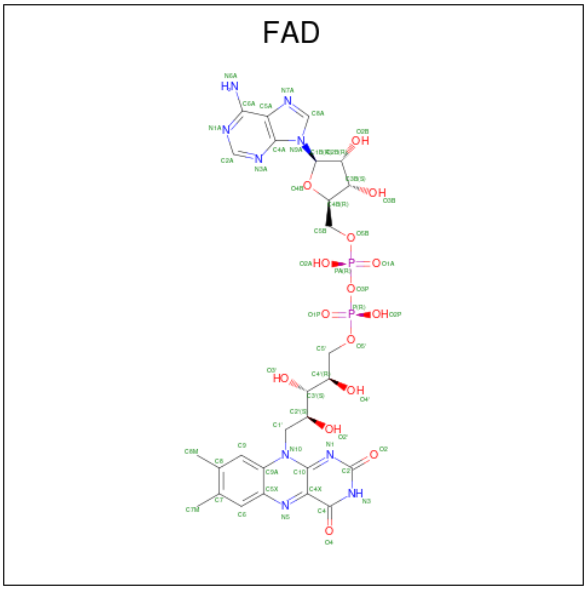
Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	PRO	-	expression tag	UNP P15559
A	-1	HIS	-	expression tag	UNP P15559
B	-3	GLY	-	expression tag	UNP P15559
B	-2	PRO	-	expression tag	UNP P15559
B	-1	HIS	-	expression tag	UNP P15559
C	-3	GLY	-	expression tag	UNP P15559
C	-2	PRO	-	expression tag	UNP P15559
C	-1	HIS	-	expression tag	UNP P15559
D	-3	GLY	-	expression tag	UNP P15559
D	-2	PRO	-	expression tag	UNP P15559
D	-1	HIS	-	expression tag	UNP P15559
E	-3	GLY	-	expression tag	UNP P15559
E	-2	PRO	-	expression tag	UNP P15559
E	-1	HIS	-	expression tag	UNP P15559
F	-3	GLY	-	expression tag	UNP P15559
F	-2	PRO	-	expression tag	UNP P15559
F	-1	HIS	-	expression tag	UNP P15559
G	-3	GLY	-	expression tag	UNP P15559
G	-2	PRO	-	expression tag	UNP P15559
G	-1	HIS	-	expression tag	UNP P15559
H	-3	GLY	-	expression tag	UNP P15559
H	-2	PRO	-	expression tag	UNP P15559
H	-1	HIS	-	expression tag	UNP P15559
I	-3	GLY	-	expression tag	UNP P15559
I	-2	PRO	-	expression tag	UNP P15559
I	-1	HIS	-	expression tag	UNP P15559
J	-3	GLY	-	expression tag	UNP P15559
J	-2	PRO	-	expression tag	UNP P15559
J	-1	HIS	-	expression tag	UNP P15559
K	-3	GLY	-	expression tag	UNP P15559
K	-2	PRO	-	expression tag	UNP P15559
K	-1	HIS	-	expression tag	UNP P15559
L	-3	GLY	-	expression tag	UNP P15559
L	-2	PRO	-	expression tag	UNP P15559
L	-1	HIS	-	expression tag	UNP P15559
M	-3	GLY	-	expression tag	UNP P15559
M	-2	PRO	-	expression tag	UNP P15559
M	-1	HIS	-	expression tag	UNP P15559
N	-3	GLY	-	expression tag	UNP P15559
N	-2	PRO	-	expression tag	UNP P15559
N	-1	HIS	-	expression tag	UNP P15559

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula:

$C_{27}H_{33}N_9O_{15}P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	B	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	C	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	D	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	E	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	F	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	G	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	H	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	I	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	J	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	K	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	L	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	M	1	Total	C	N	O	P	0	0
			53	27	9	15	2		

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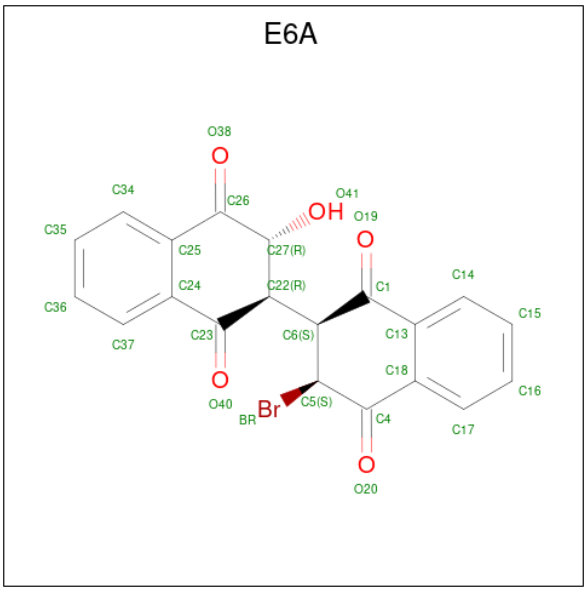
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	N	1	Total	C	N	O	P	0	0
			53	27	9	15	2		

- Molecule 3 is (2 {R},3 {R})-2-[(2 {S},3 {S})-3-bromanyl-1,4-bis(oxidanylidene)-2,3-dihydronaphthalen-2-yl]-3-oxidanyl-2,3-dihydronaphthalene-1,4-dione (three-letter code: E6A) (formula: $C_{20}H_{13}BrO_5$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	B	1	Total	Br	C	O		0	0
			26	1	20	5			
3	E	1	Total	Br	C	O		0	0
			26	1	20	5			
3	H	1	Total	Br	C	O		0	0
			26	1	20	5			
3	K	1	Total	Br	C	O		0	0
			26	1	20	5			
3	M	1	Total	Br	C	O		0	0
			26	1	20	5			

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	4	Total	O	0	0
			4	4		
4	B	4	Total	O	0	0
			4	4		

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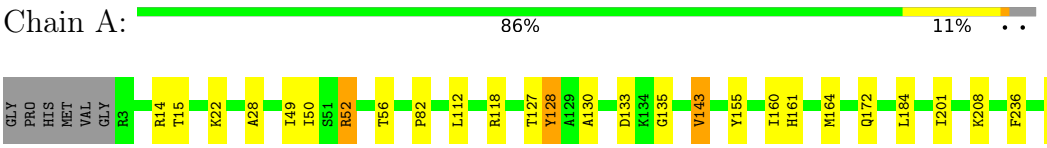
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	C	1	Total O 1 1	0	0
4	D	4	Total O 4 4	0	0
4	E	6	Total O 6 6	0	0
4	F	2	Total O 2 2	0	0
4	G	1	Total O 1 1	0	0
4	H	3	Total O 3 3	0	0
4	I	8	Total O 8 8	0	0
4	J	4	Total O 4 4	0	0
4	K	3	Total O 3 3	0	0
4	L	4	Total O 4 4	0	0
4	M	3	Total O 3 3	0	0
4	N	3	Total O 3 3	0	0

3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density (RSRZ > 2). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

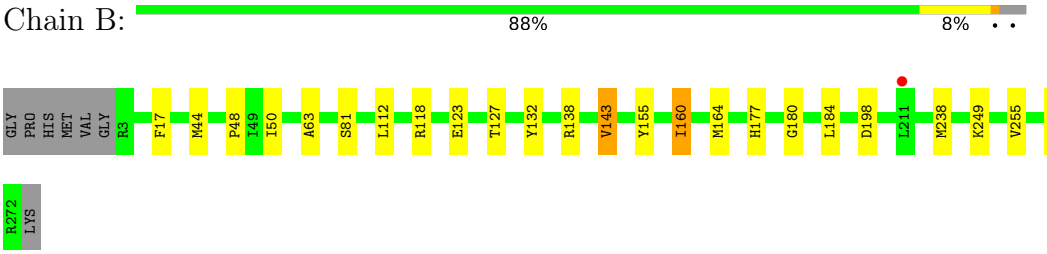
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

Chain A:



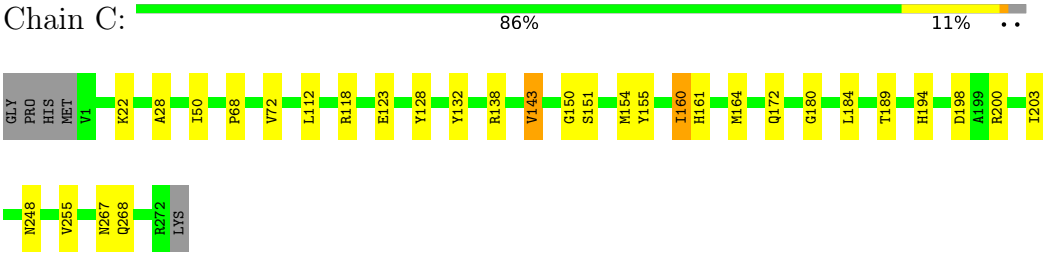
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

Chain B:



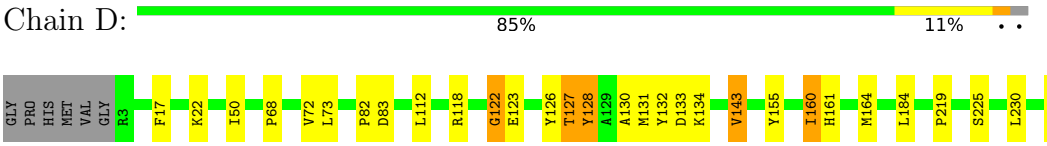
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

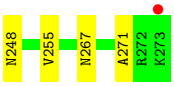
Chain C:



• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

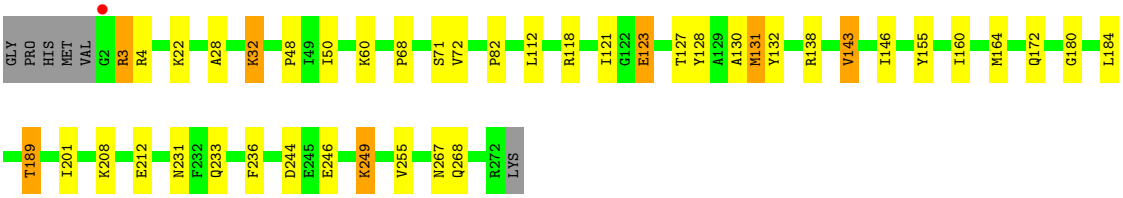
Chain D:





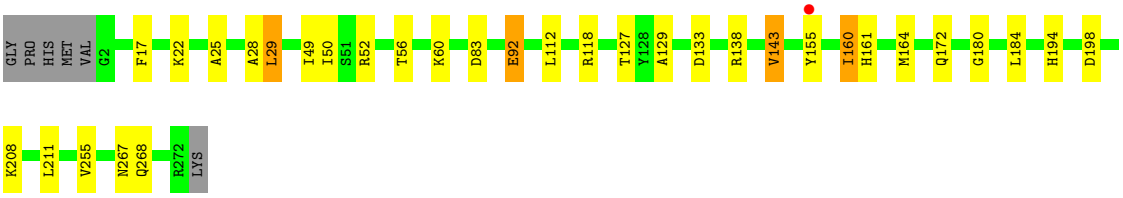
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

Chain E:



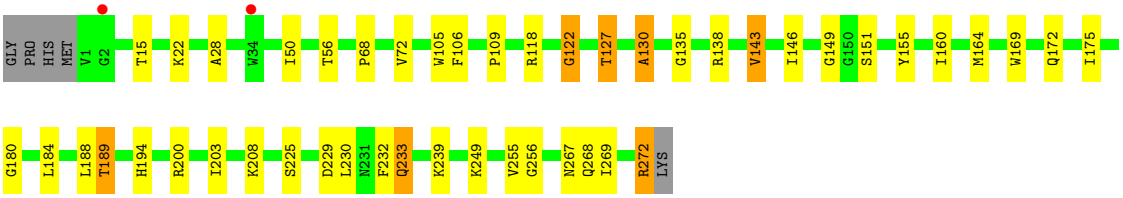
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

Chain F:



• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

Chain G:

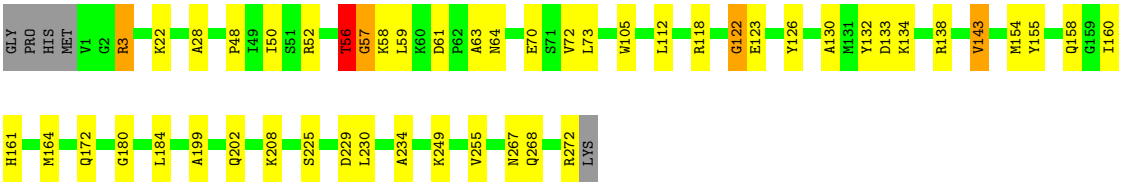


• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

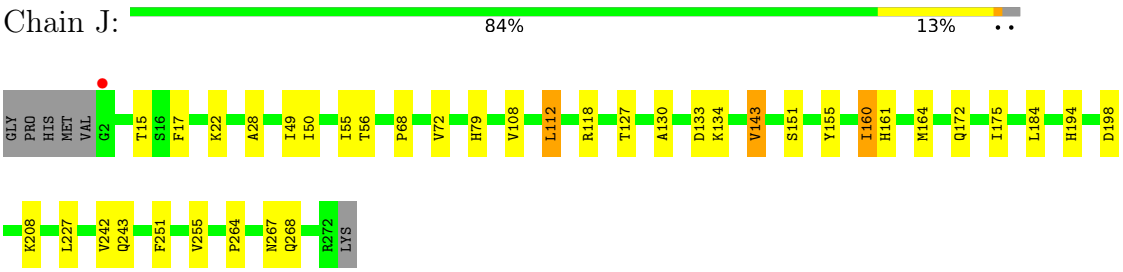
Chain H:

• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

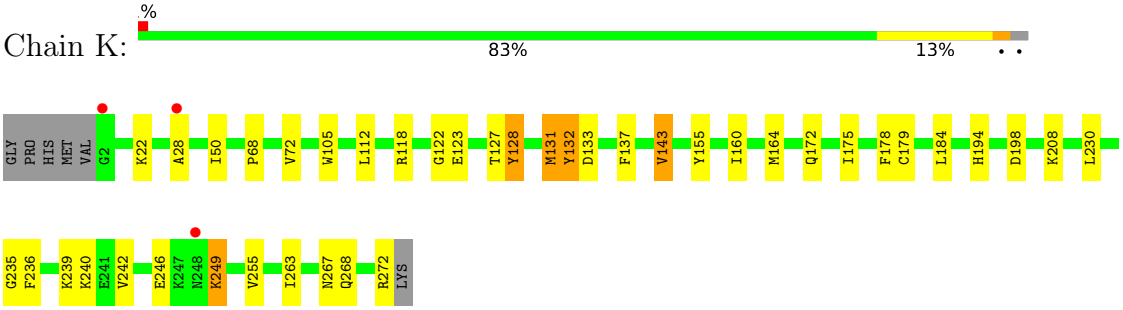
Chain I:



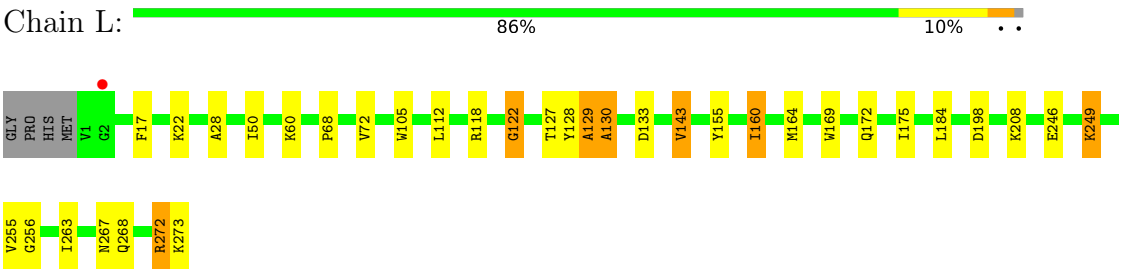
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1



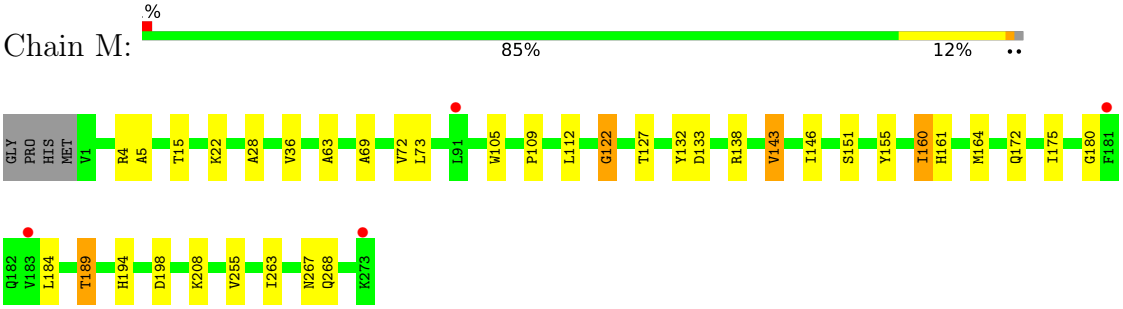
• Molecule 1: NAD(P)H dehydrogenase [quinone] 1



• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

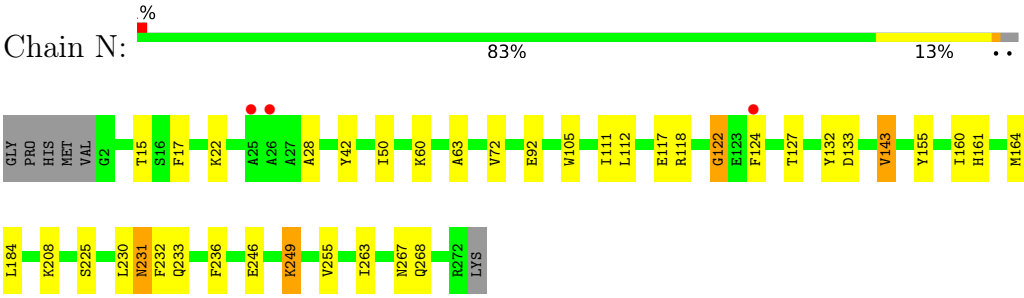


• Molecule 1: NAD(P)H dehydrogenase [quinone] 1



• Molecule 1: NAD(P)H dehydrogenase [quinone] 1

Chain N:


%
83%
13%
GLY PRO HIS MET VAL G2 T15 S16 F17 K22 A25 A26 A27 A28 Y42 I50 K60 A63 V72 E92 W105 I111 L112 E117 R118 G122 E123 F124 T127 Y132 D133 V143 Y155 I160 H161 M164 Q172 I175
L184 K208 S225 L230 N231 F232 Q233 F236 E246 K249 V255 I263 N267 Q268 R272 LYS

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	95.60Å 210.77Å 228.08Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	95.67 – 2.90 95.67 – 2.90	Depositor EDS
% Data completeness (in resolution range)	99.9 (95.67-2.90) 99.9 (95.67-2.90)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.12	Depositor
$< I/\sigma(I) >$ [1]	1.24 (at 2.91Å)	Xtriage
Refinement program	BUSTER 2.10.2	Depositor
R, R_{free}	0.183 , 0.220 0.205 , 0.240	Depositor DCC
R_{free} test set	4972 reflections (4.84%)	wwPDB-VP
Wilson B-factor (Å^2)	60.8	Xtriage
Anisotropy	0.625	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 73.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	31021	wwPDB-VP
Average B, all atoms (Å^2)	73.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.04% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: FAD, E6A

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	#$\|Z\|>5$	RMSZ	#$\|Z\|>5$
1	A	0.53	0/2190	0.69	0/2961
1	B	0.50	0/2179	0.68	0/2951
1	C	0.55	0/2219	0.68	0/3000
1	D	0.53	0/2222	0.70	0/3000
1	E	0.55	0/2213	0.69	0/2990
1	F	0.53	0/2210	0.71	2/2987 (0.1%)
1	G	0.52	0/2195	0.73	1/2967 (0.0%)
1	H	0.52	0/2216	0.68	0/2994
1	I	0.52	0/2221	0.71	0/3001
1	J	0.51	0/2205	0.68	0/2979
1	K	0.52	0/2212	0.69	0/2989
1	L	0.54	0/2221	0.73	1/2999 (0.0%)
1	M	0.52	0/2209	0.69	0/2989
1	N	0.53	0/2192	0.70	0/2966
All	All	0.53	0/30904	0.70	4/41773 (0.0%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	L	129	ALA	C-N-CA	8.81	143.72	121.70
1	F	92	GLU	CB-CG-CD	5.52	129.12	114.20
1	F	129	ALA	N-CA-C	-5.32	96.64	111.00
1	G	233	GLN	N-CA-C	-5.08	97.29	111.00

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2134	0	2119	23	0
1	B	2122	0	2085	17	0
1	C	2161	0	2155	21	0
1	D	2164	0	2164	23	0
1	E	2155	0	2150	25	0
1	F	2152	0	2143	24	0
1	G	2139	0	2133	30	0
1	H	2158	0	2154	16	0
1	I	2163	0	2159	31	0
1	J	2148	0	2143	26	0
1	K	2154	0	2148	22	0
1	L	2164	0	2166	20	0
1	M	2151	0	2125	22	0
1	N	2134	0	2108	27	0
2	A	53	0	31	1	0
2	B	53	0	31	1	0
2	C	53	0	31	0	0
2	D	53	0	31	1	0
2	E	53	0	31	0	0
2	F	53	0	31	1	0
2	G	53	0	31	0	0
2	H	53	0	31	1	0
2	I	53	0	31	0	0
2	J	53	0	31	1	0
2	K	53	0	31	0	0
2	L	53	0	31	1	0
2	M	53	0	31	0	0
2	N	53	0	31	1	0
3	B	26	0	12	2	0
3	E	26	0	12	2	0
3	H	26	0	12	3	0
3	K	26	0	12	2	0
3	M	26	0	12	2	0
4	A	4	0	0	0	0
4	B	4	0	0	0	0
4	C	1	0	0	0	0
4	D	4	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	E	6	0	0	0	0
4	F	2	0	0	0	0
4	G	1	0	0	0	0
4	H	3	0	0	0	0
4	I	8	0	0	0	0
4	J	4	0	0	0	0
4	K	3	0	0	0	0
4	L	4	0	0	0	0
4	M	3	0	0	0	0
4	N	3	0	0	0	0
All	All	31021	0	30446	278	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 5.

The worst 5 of 278 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:L:72:VAL:HG22	1:L:122:GLY:HA3	1.36	1.08
3:E:602:E6A:H5	3:E:602:E6A:BR	2.15	1.01
1:G:72:VAL:HG22	1:G:122:GLY:HA3	1.43	0.97
3:B:302:E6A:H5	3:B:302:E6A:BR	2.21	0.95
1:J:108:VAL:HG13	1:J:112:LEU:HB3	1.49	0.91

There are no symmetry-related clashes.

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	268/277 (97%)	254 (95%)	14 (5%)	0	100	100
1	B	268/277 (97%)	256 (96%)	12 (4%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	C	270/277 (98%)	259 (96%)	10 (4%)	1 (0%)	34 66
1	D	269/277 (97%)	255 (95%)	12 (4%)	2 (1%)	22 54
1	E	269/277 (97%)	255 (95%)	12 (4%)	2 (1%)	22 54
1	F	269/277 (97%)	259 (96%)	10 (4%)	0	100 100
1	G	270/277 (98%)	249 (92%)	16 (6%)	5 (2%)	8 28
1	H	269/277 (97%)	253 (94%)	14 (5%)	2 (1%)	22 54
1	I	270/277 (98%)	260 (96%)	7 (3%)	3 (1%)	14 42
1	J	269/277 (97%)	253 (94%)	16 (6%)	0	100 100
1	K	269/277 (97%)	256 (95%)	11 (4%)	2 (1%)	22 54
1	L	271/277 (98%)	255 (94%)	12 (4%)	4 (2%)	10 34
1	M	271/277 (98%)	260 (96%)	10 (4%)	1 (0%)	34 66
1	N	269/277 (97%)	251 (93%)	17 (6%)	1 (0%)	34 66
All	All	3771/3878 (97%)	3575 (95%)	173 (5%)	23 (1%)	25 58

5 of 23 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	271	ALA
1	E	131	MET
1	G	130	ALA
1	H	122	GLY
1	I	56	THR

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	A	221/230 (96%)	212 (96%)	9 (4%)	30 64
1	B	218/230 (95%)	211 (97%)	7 (3%)	39 73
1	C	225/230 (98%)	217 (96%)	8 (4%)	35 69
1	D	226/230 (98%)	214 (95%)	12 (5%)	22 54

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	E	224/230 (97%)	212 (95%)	12 (5%)	22 54
1	F	224/230 (97%)	214 (96%)	10 (4%)	27 61
1	G	220/230 (96%)	212 (96%)	8 (4%)	35 69
1	H	225/230 (98%)	217 (96%)	8 (4%)	35 69
1	I	225/230 (98%)	212 (94%)	13 (6%)	20 50
1	J	223/230 (97%)	217 (97%)	6 (3%)	44 77
1	K	224/230 (97%)	212 (95%)	12 (5%)	22 54
1	L	225/230 (98%)	217 (96%)	8 (4%)	35 69
1	M	221/230 (96%)	212 (96%)	9 (4%)	30 64
1	N	220/230 (96%)	212 (96%)	8 (4%)	35 69
All	All	3121/3220 (97%)	2991 (96%)	130 (4%)	30 63

5 of 130 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	M	112	LEU
1	M	160	ILE
1	F	22	LYS
1	E	249	LYS
1	M	198	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 59 such sidechains are listed below:

Mol	Chain	Res	Type
1	G	231	ASN
1	M	268	GLN
1	I	202	GLN
1	M	267	ASN
1	L	267	ASN

5.3.3 RNA

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

19 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
3	E6A	K	602	-	28,29,29	2.26	5 (17%)	33,44,44	2.32	11 (33%)
2	FAD	D	301	-	53,58,58	0.58	0	68,89,89	0.62	2 (2%)
2	FAD	K	601	-	53,58,58	0.52	0	68,89,89	0.66	2 (2%)
2	FAD	A	601	-	53,58,58	0.52	0	68,89,89	0.63	1 (1%)
2	FAD	G	601	-	53,58,58	0.47	0	68,89,89	0.63	1 (1%)
2	FAD	E	601	-	53,58,58	0.49	0	68,89,89	0.68	2 (2%)
2	FAD	C	601	-	53,58,58	0.57	0	68,89,89	0.66	2 (2%)
2	FAD	H	301	-	53,58,58	0.58	0	68,89,89	0.57	1 (1%)
3	E6A	E	602	-	28,29,29	2.59	7 (25%)	33,44,44	2.11	11 (33%)
2	FAD	B	301	-	53,58,58	0.51	0	68,89,89	0.59	1 (1%)
2	FAD	J	301	-	53,58,58	0.47	0	68,89,89	0.57	1 (1%)
2	FAD	M	601	-	53,58,58	0.48	0	68,89,89	0.61	1 (1%)
2	FAD	I	601	-	53,58,58	0.52	0	68,89,89	0.64	1 (1%)
3	E6A	M	602	-	28,29,29	2.52	6 (21%)	33,44,44	2.45	10 (30%)
2	FAD	F	301	-	53,58,58	0.54	0	68,89,89	0.57	1 (1%)
3	E6A	H	302	-	28,29,29	2.51	6 (21%)	33,44,44	2.30	13 (39%)
3	E6A	B	302	-	28,29,29	2.30	4 (14%)	33,44,44	2.32	9 (27%)
2	FAD	L	301	-	53,58,58	0.57	0	68,89,89	0.53	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
2	FAD	N	301	-	53,58,58	0.56	0	68,89,89	0.58	1 (1%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	E6A	K	602	-	-	3/4/44/44	0/4/4/4
2	FAD	D	301	-	-	4/30/50/50	0/6/6/6
2	FAD	K	601	-	-	1/30/50/50	0/6/6/6
2	FAD	A	601	-	-	2/30/50/50	0/6/6/6
2	FAD	G	601	-	-	1/30/50/50	0/6/6/6
2	FAD	E	601	-	-	1/30/50/50	0/6/6/6
2	FAD	C	601	-	-	3/30/50/50	0/6/6/6
2	FAD	H	301	-	-	5/30/50/50	0/6/6/6
3	E6A	E	602	-	-	3/4/44/44	0/4/4/4
2	FAD	B	301	-	-	5/30/50/50	0/6/6/6
2	FAD	J	301	-	-	3/30/50/50	0/6/6/6
2	FAD	M	601	-	-	1/30/50/50	0/6/6/6
2	FAD	I	601	-	-	2/30/50/50	0/6/6/6
3	E6A	M	602	-	-	3/4/44/44	0/4/4/4
2	FAD	F	301	-	-	5/30/50/50	0/6/6/6
3	E6A	H	302	-	-	3/4/44/44	0/4/4/4
3	E6A	B	302	-	-	3/4/44/44	0/4/4/4
2	FAD	L	301	-	-	6/30/50/50	0/6/6/6
2	FAD	N	301	-	-	5/30/50/50	0/6/6/6

The worst 5 of 28 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	M	602	E6A	C6-C5	9.54	1.64	1.53
3	H	302	E6A	C6-C5	9.43	1.64	1.53
3	E	602	E6A	C6-C5	8.69	1.63	1.53
3	B	302	E6A	C6-C5	8.61	1.63	1.53
3	K	602	E6A	C6-C5	8.47	1.63	1.53

The worst 5 of 71 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	M	602	E6A	BR-C5-C6	6.87	119.11	109.38
3	K	602	E6A	BR-C5-C6	6.45	118.52	109.38
3	M	602	E6A	C18-C13-C1	-6.32	114.12	120.72
3	H	302	E6A	BR-C5-C6	5.93	117.78	109.38
3	B	302	E6A	C13-C18-C4	-5.91	114.55	120.72

There are no chirality outliers.

5 of 59 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	F	301	FAD	O4B-C4B-C5B-O5B
2	H	301	FAD	O4B-C4B-C5B-O5B
2	L	301	FAD	C5B-O5B-PA-O3P
2	L	301	FAD	O4B-C4B-C5B-O5B
2	N	301	FAD	O4B-C4B-C5B-O5B

There are no ring outliers.

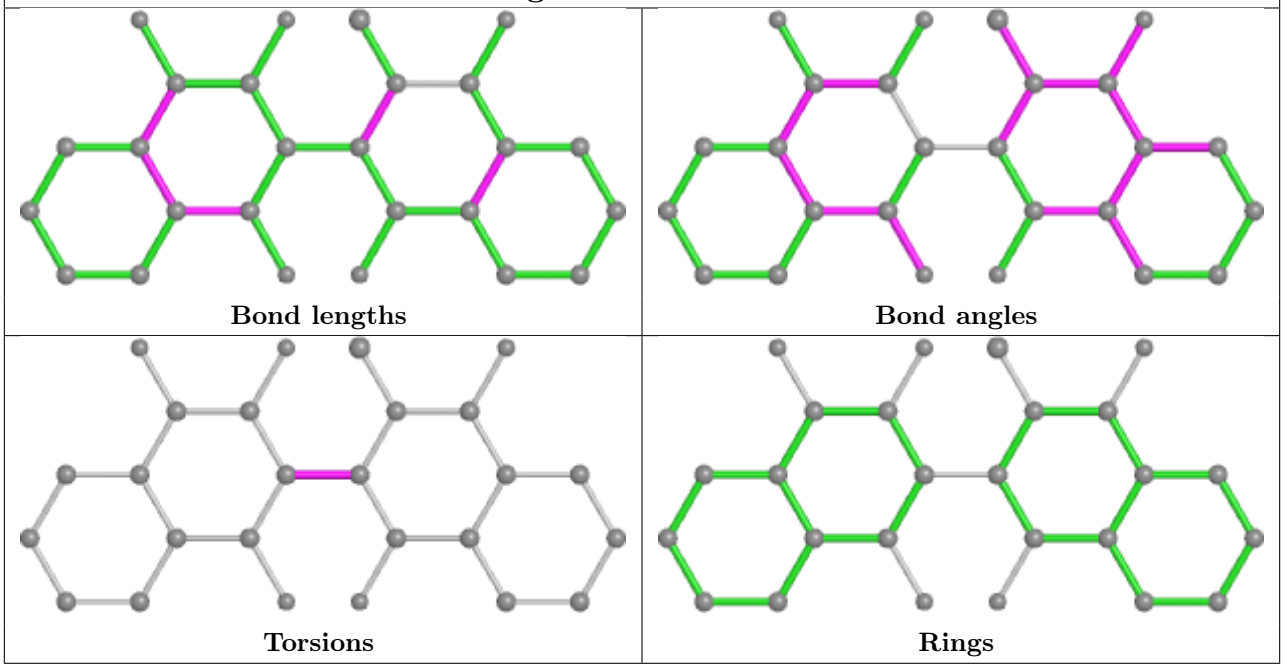
13 monomers are involved in 19 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	K	602	E6A	2	0
2	D	301	FAD	1	0
2	A	601	FAD	1	0
2	H	301	FAD	1	0
3	E	602	E6A	2	0
2	B	301	FAD	1	0
2	J	301	FAD	1	0
3	M	602	E6A	2	0
2	F	301	FAD	1	0
3	H	302	E6A	3	0
3	B	302	E6A	2	0
2	L	301	FAD	1	0
2	N	301	FAD	1	0

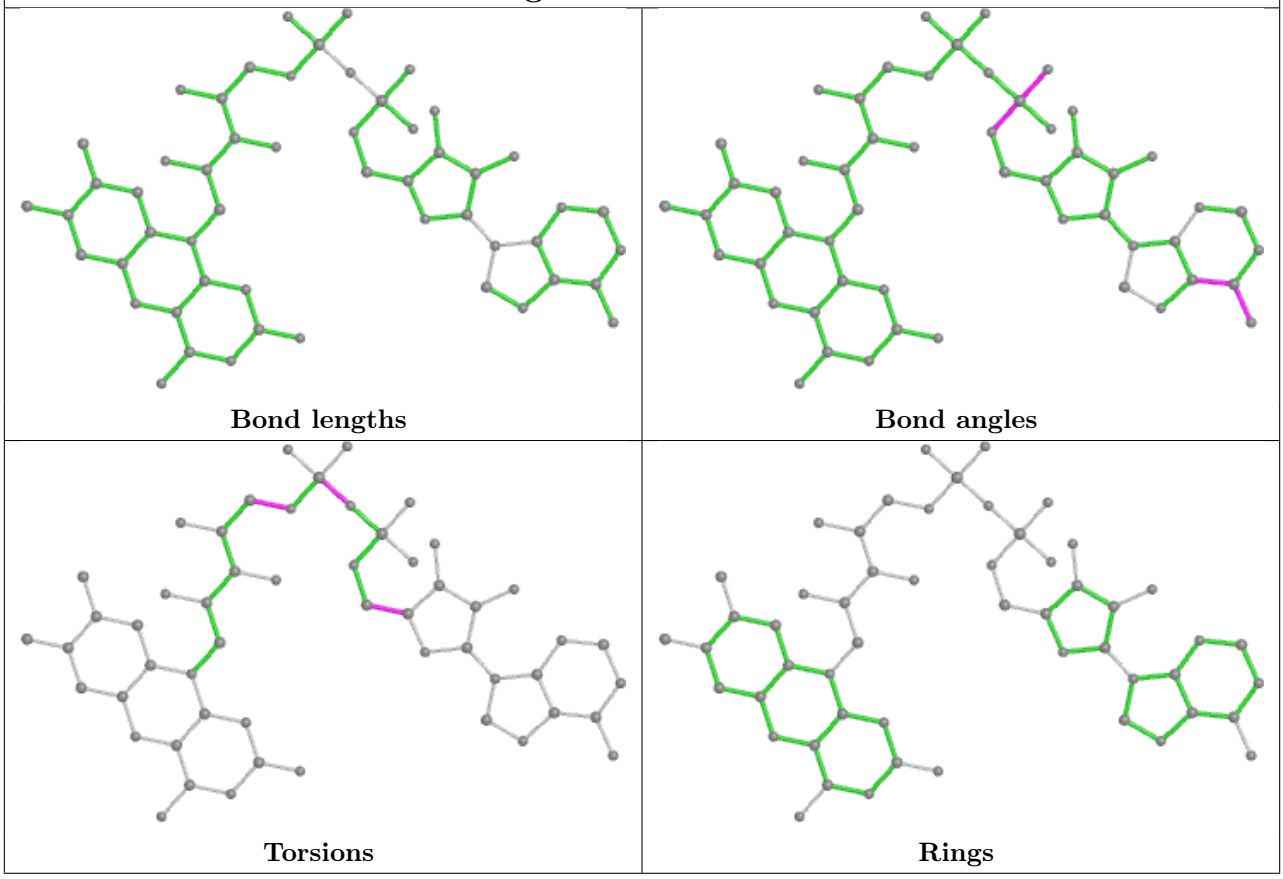
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and

any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

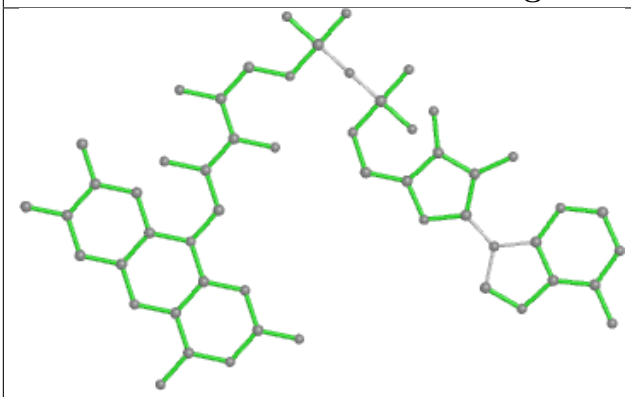
Ligand E6A K 602



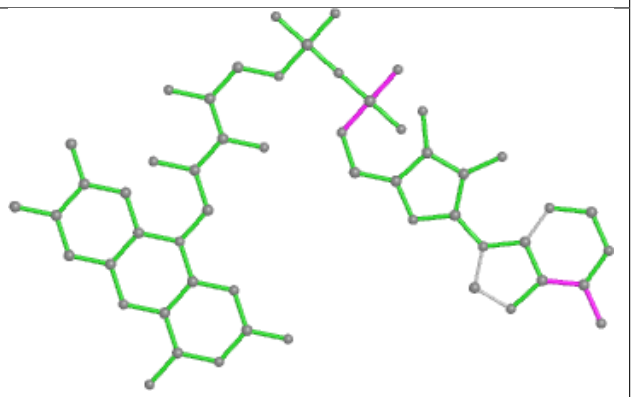
Ligand FAD D 301



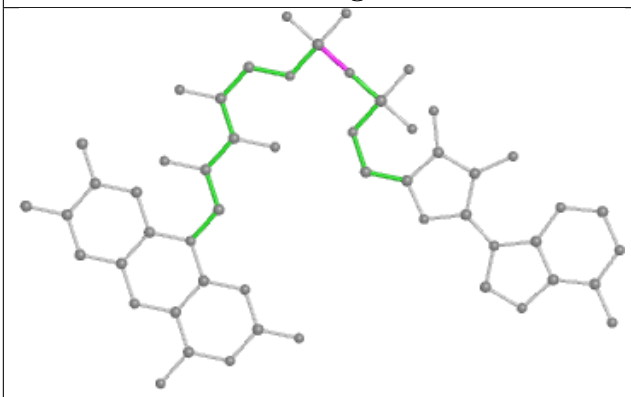
Ligand FAD K 601



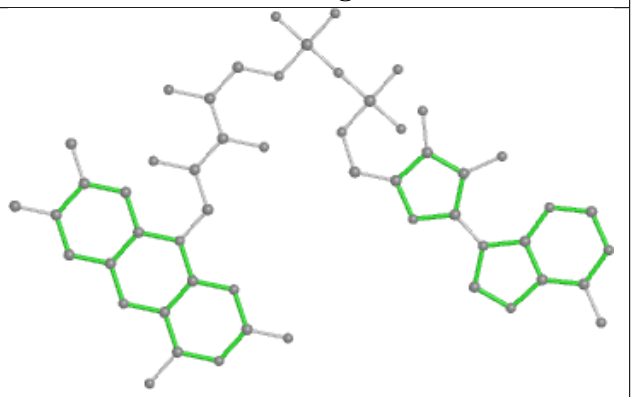
Bond lengths



Bond angles

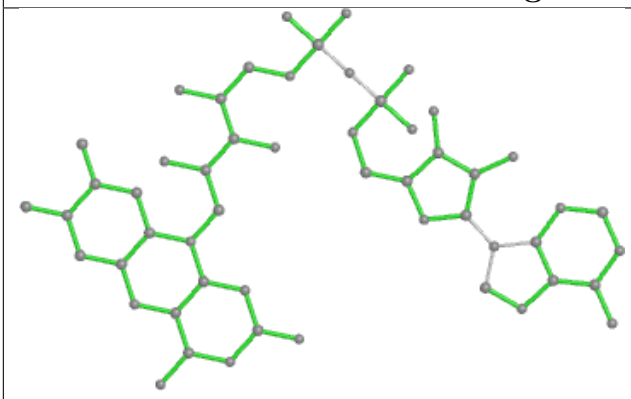


Torsions



Rings

Ligand FAD A 601



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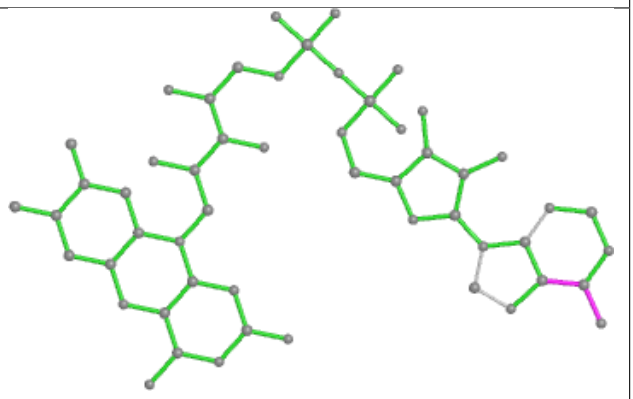

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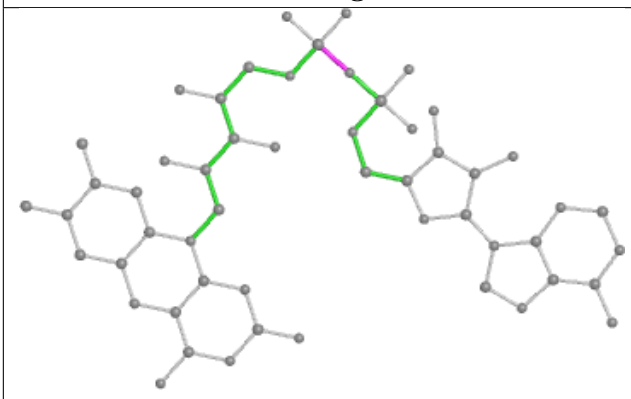
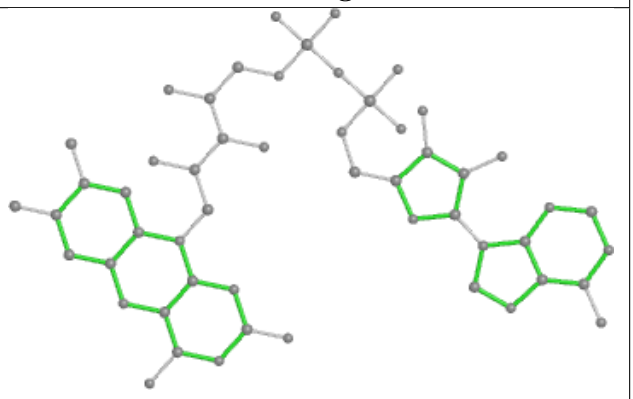
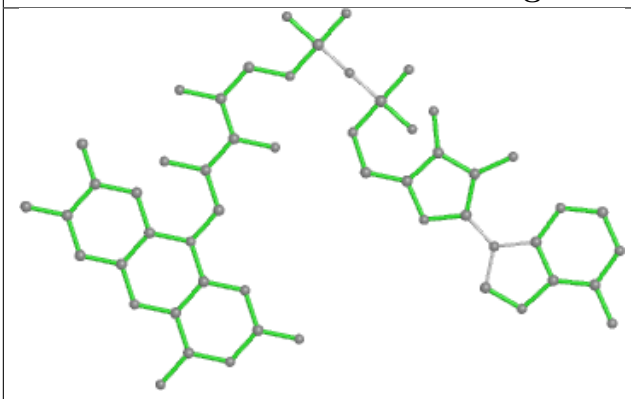


Torsions

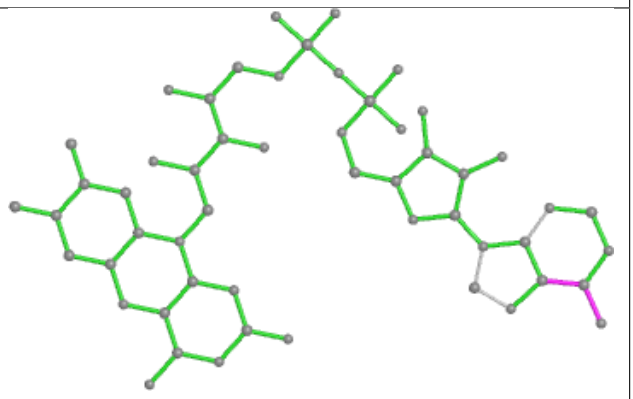


Rings

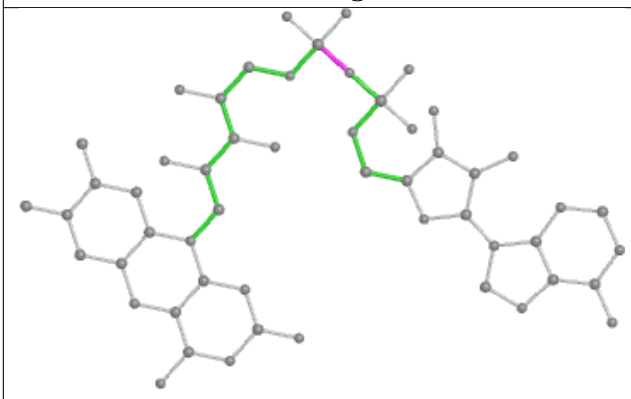
Ligand FAD G 601



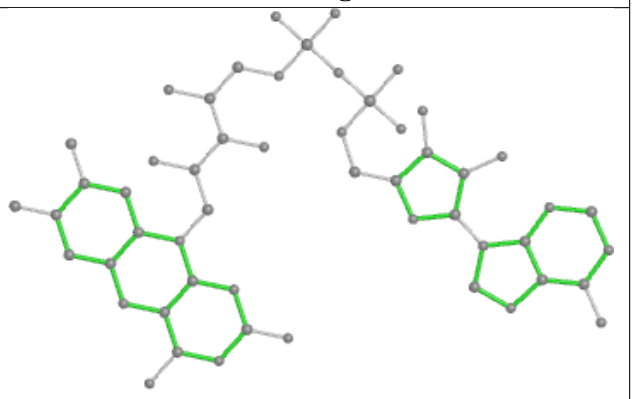
Bond lengths



Bond angles

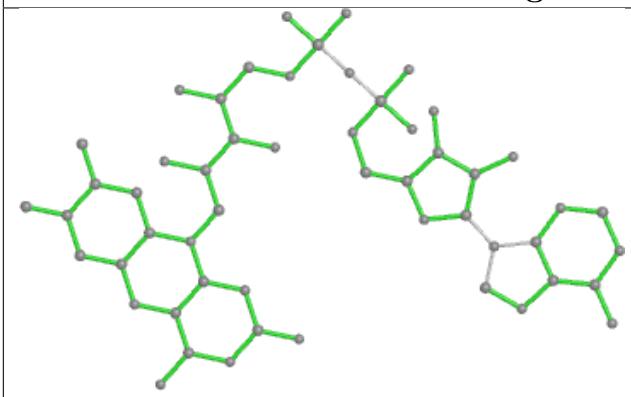


Torsions



Rings

Ligand FAD E 601



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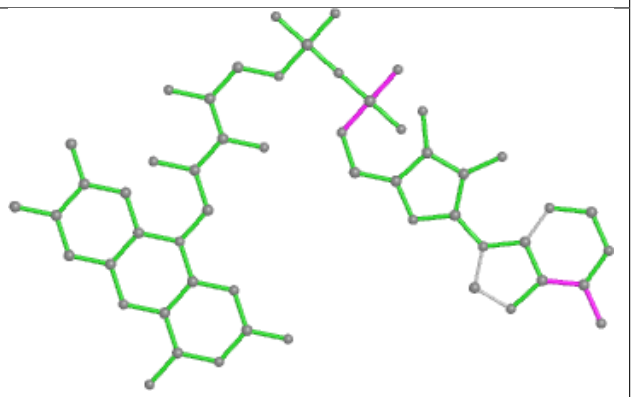
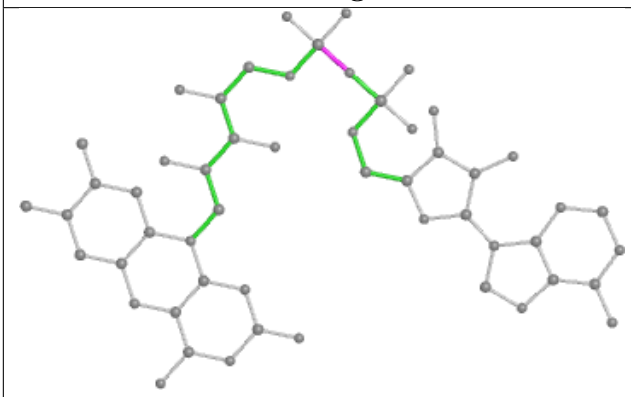
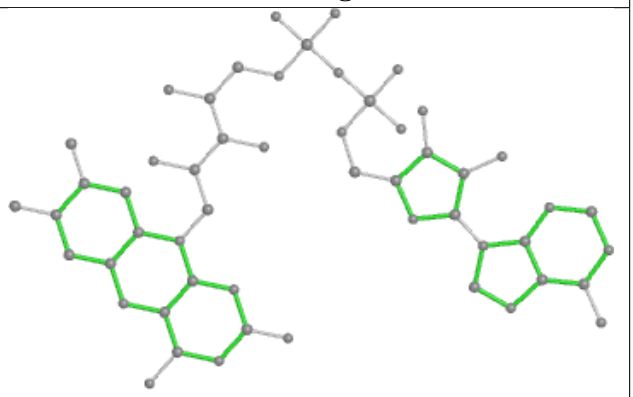


Bond angles

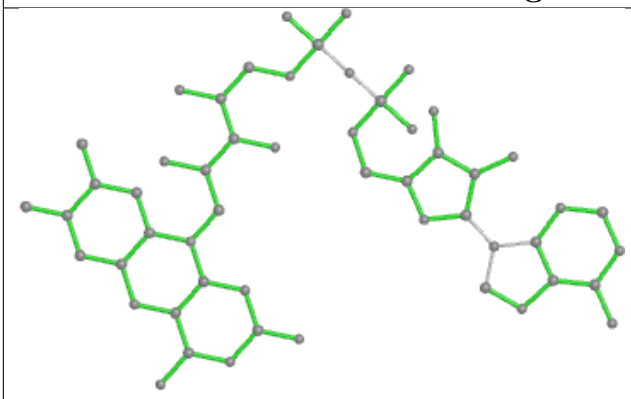


Torsions

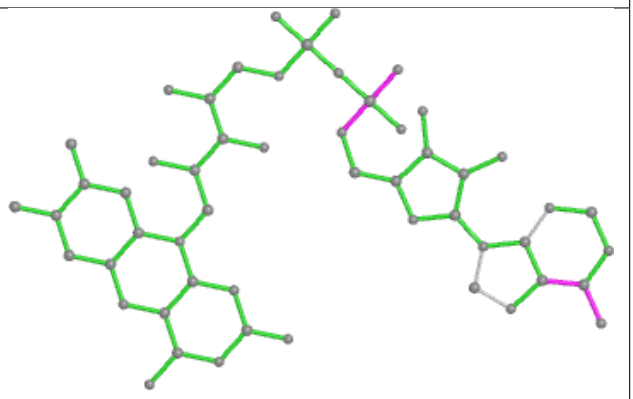


Rings

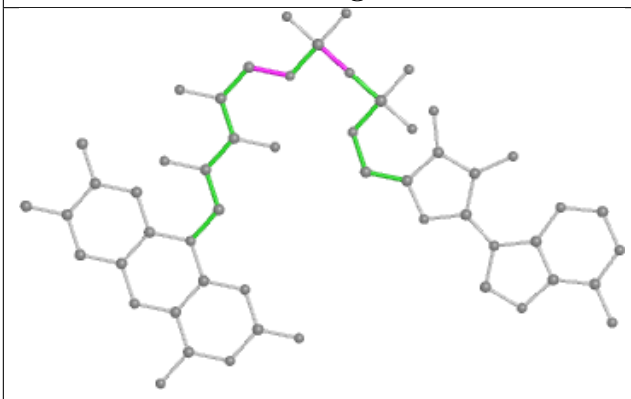
Ligand FAD C 601



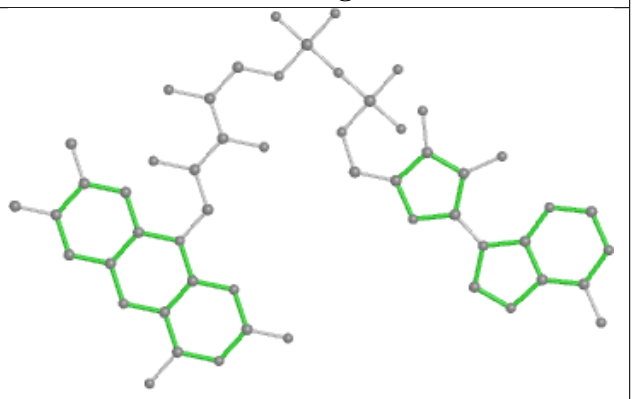
Bond lengths



Bond angles

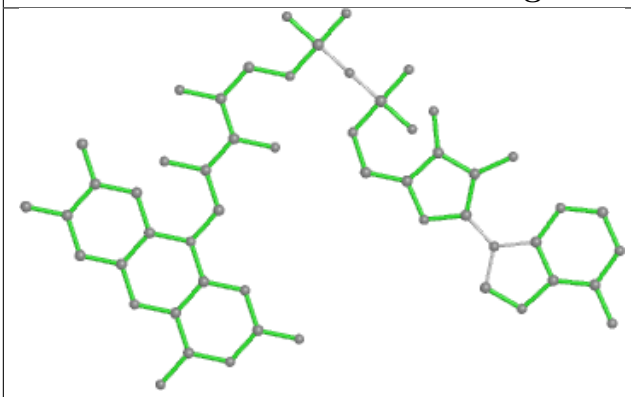


Torsions

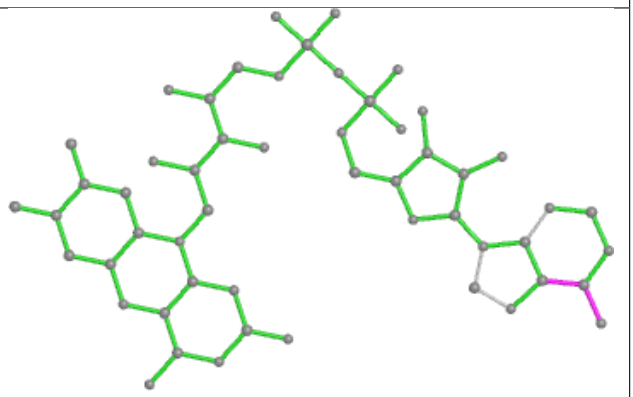


Rings

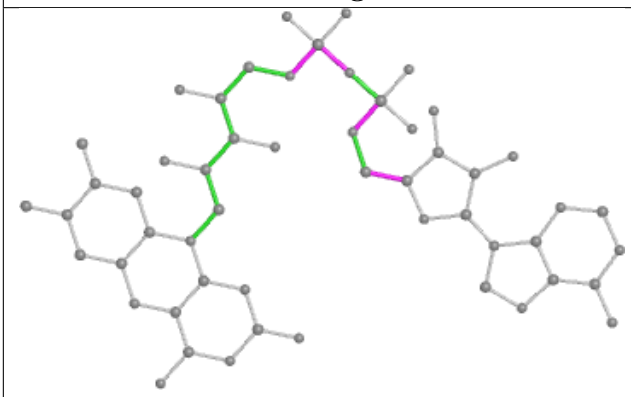
Ligand FAD H 301



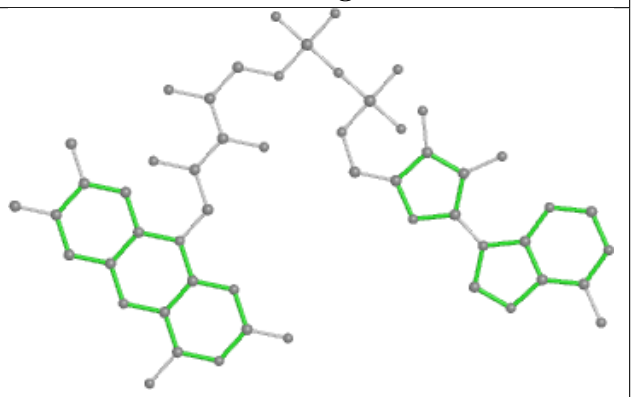
Bond lengths



Bond angles

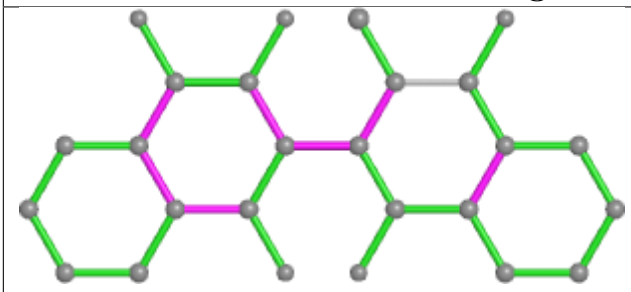


Torsions



Rings

Ligand E6A E 602



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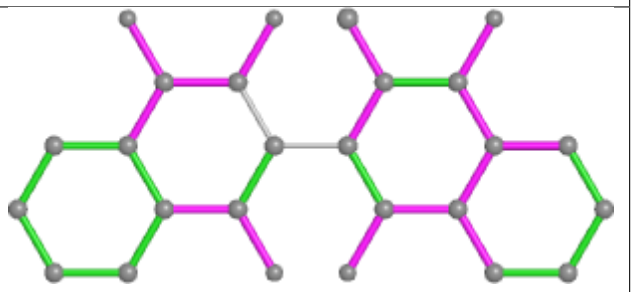

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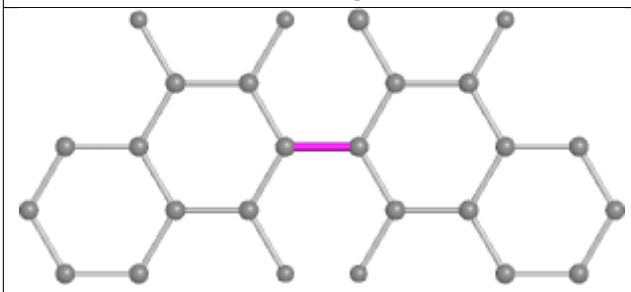

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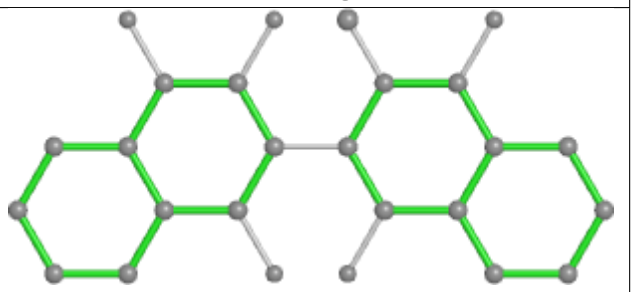
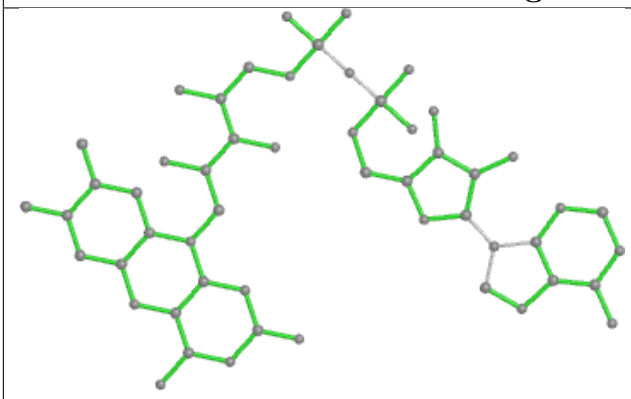
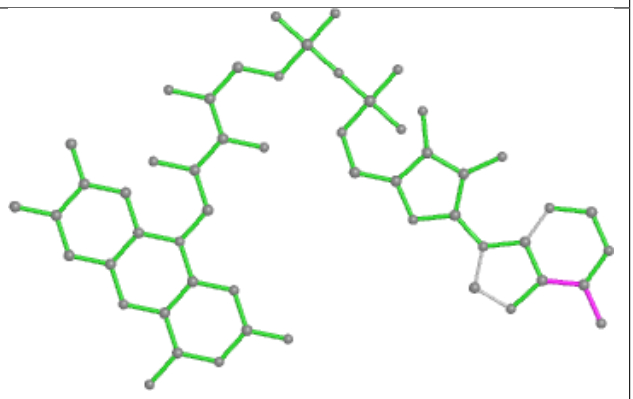


Rings

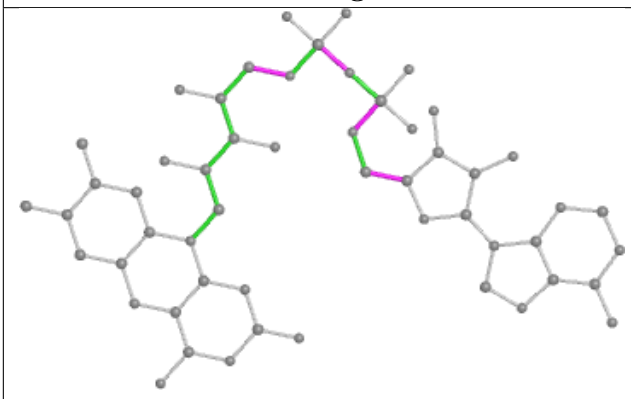
Ligand FAD B 301



Bond lengths



Bond angles



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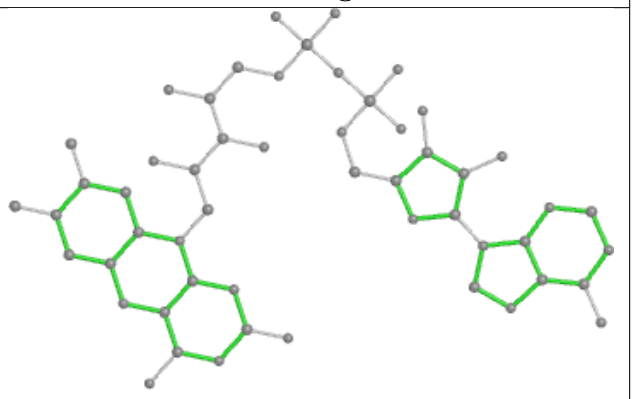
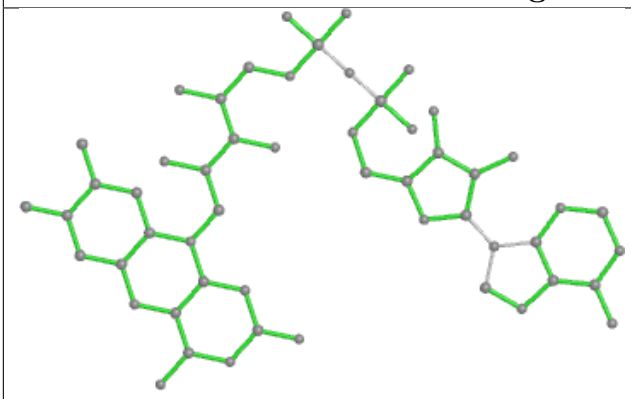
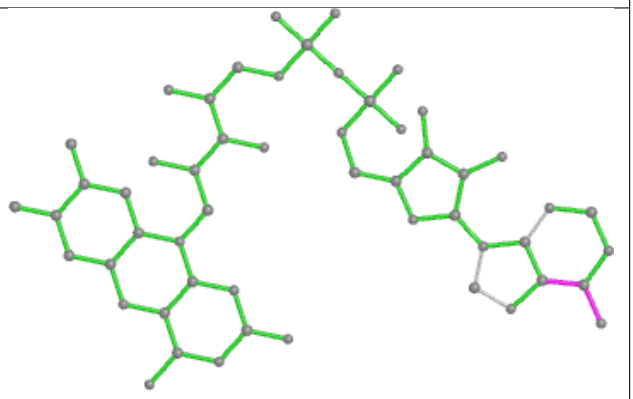


Rings

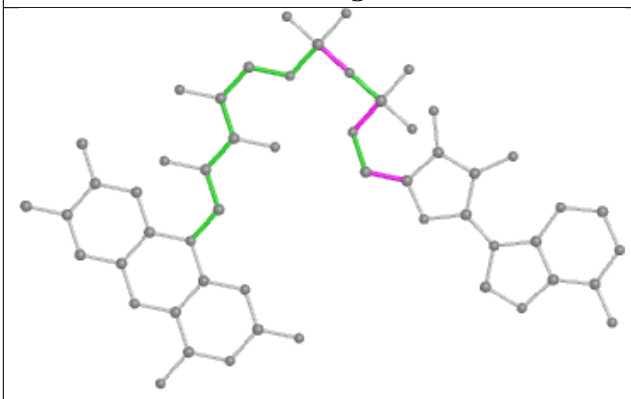
Ligand FAD J 301



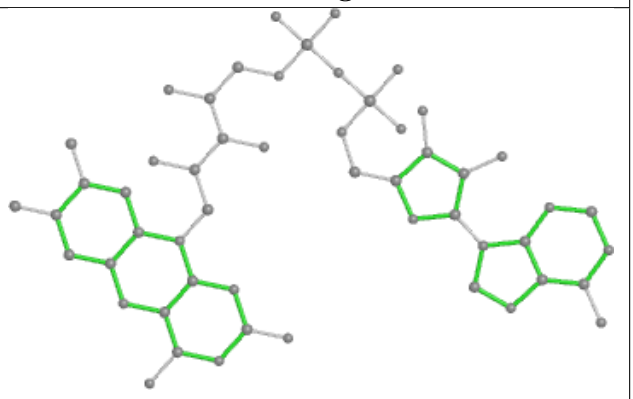
Bond lengths



Bond angles

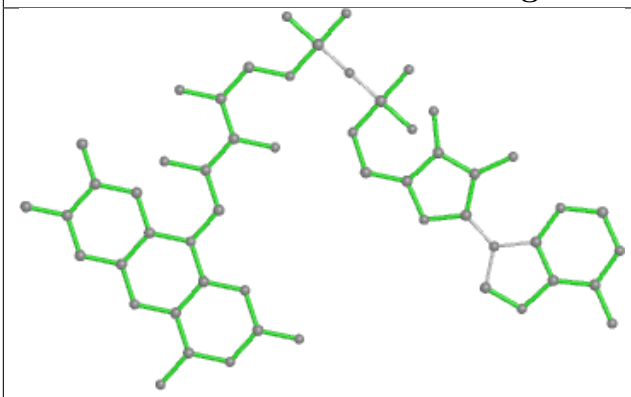


Torsions

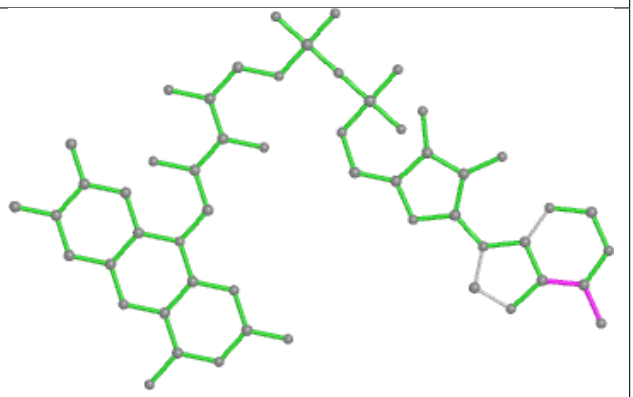


Rings

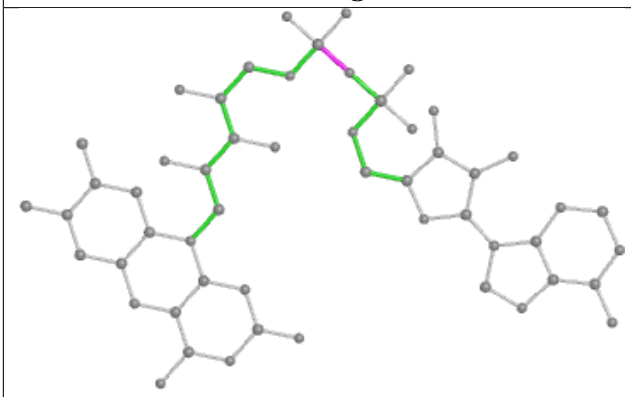
Ligand FAD M 601



Bond lengths



Bond angles



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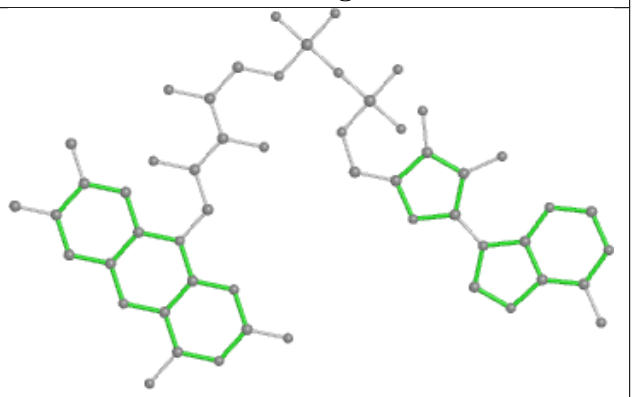
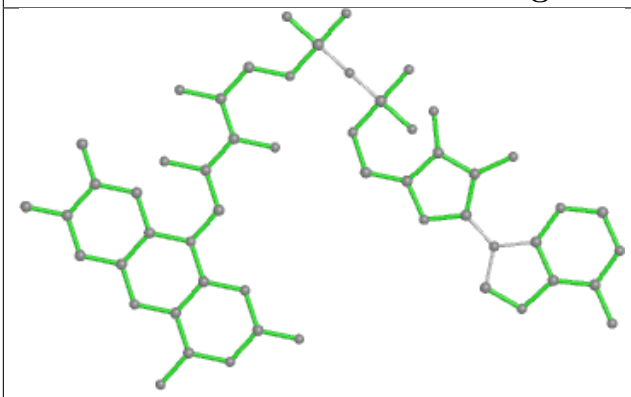
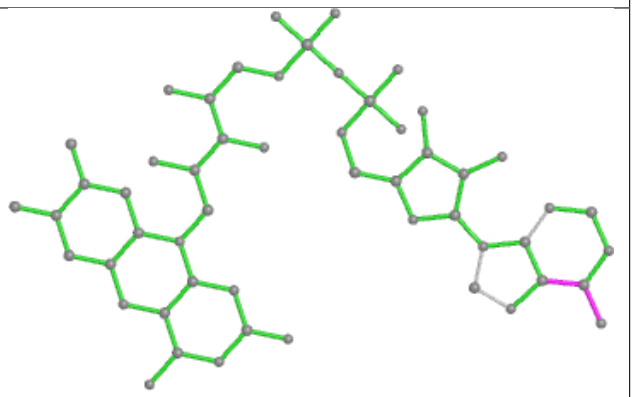


Rings

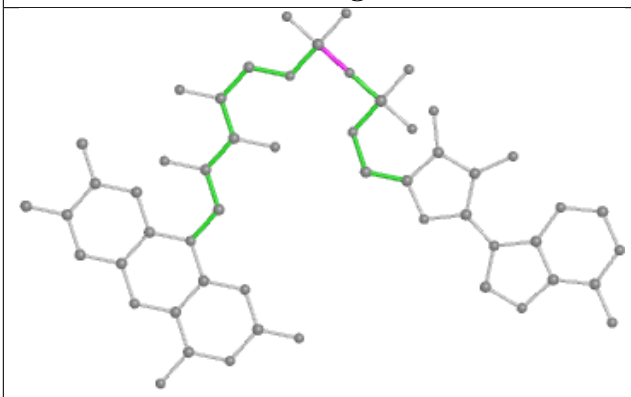
Ligand FAD I 601



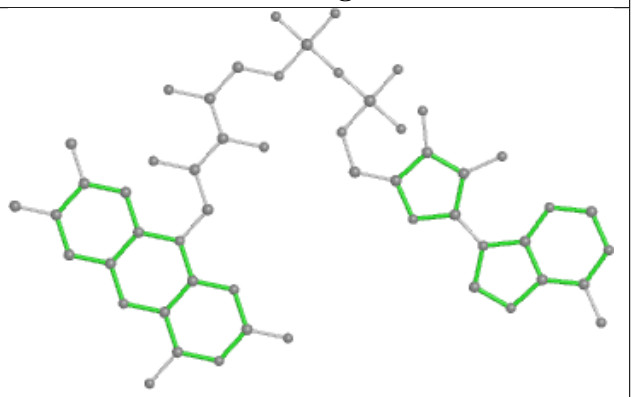
Bond lengths



Bond angles

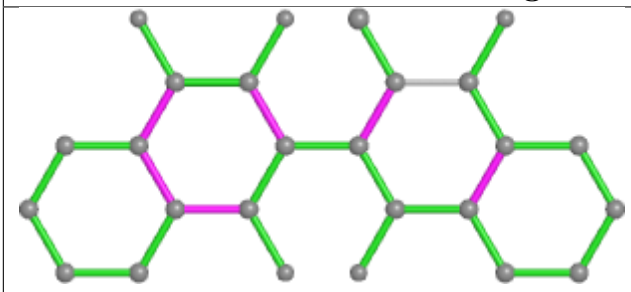


Torsions



Rings

Ligand E6A M 602



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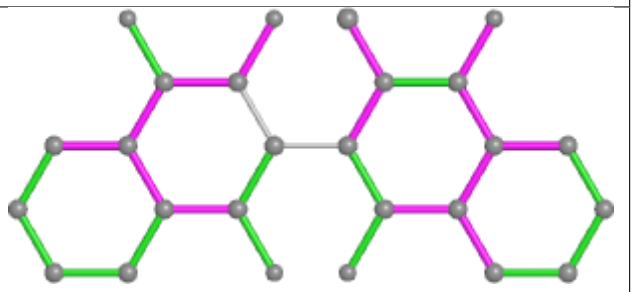
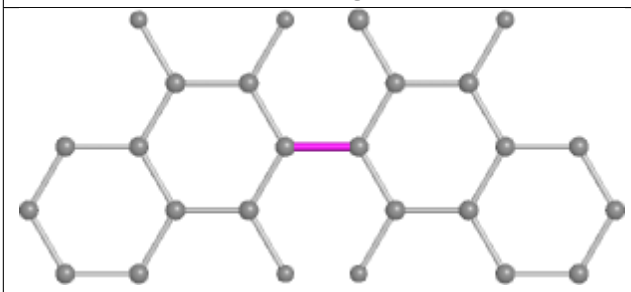


Bond angles



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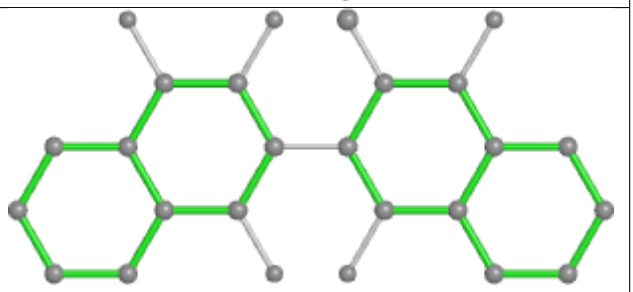
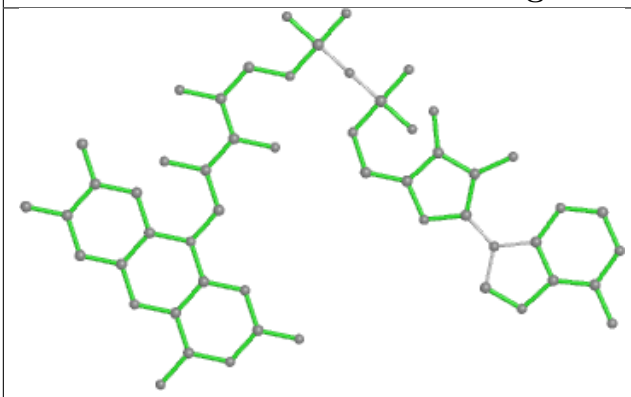


Rings

Ligand FAD F 301



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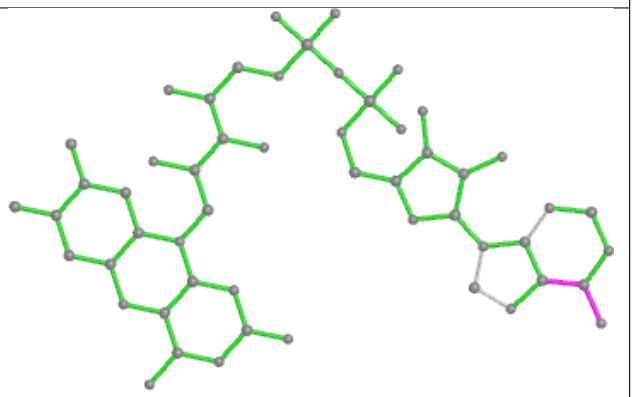
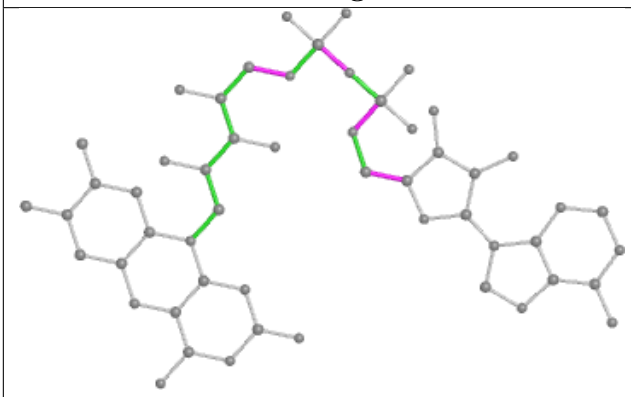


Bond angles



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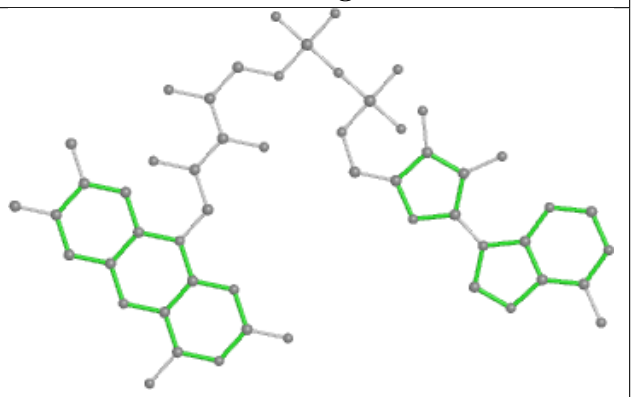
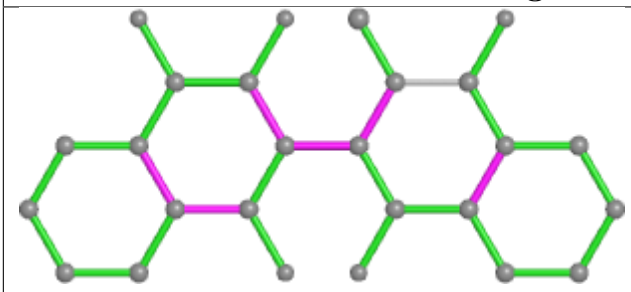
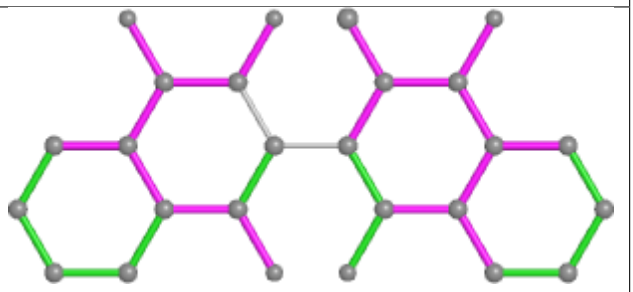


Rings

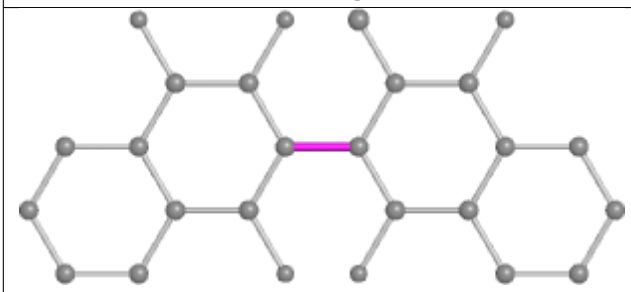
Ligand E6A H 302



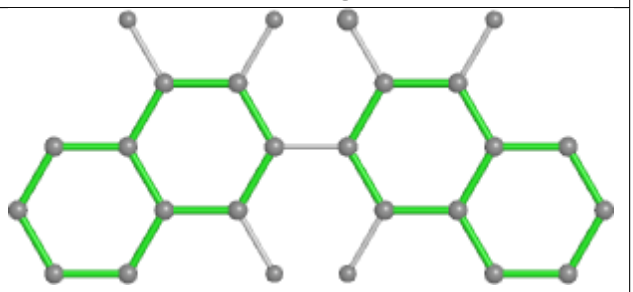
Bond lengths



Bond angles

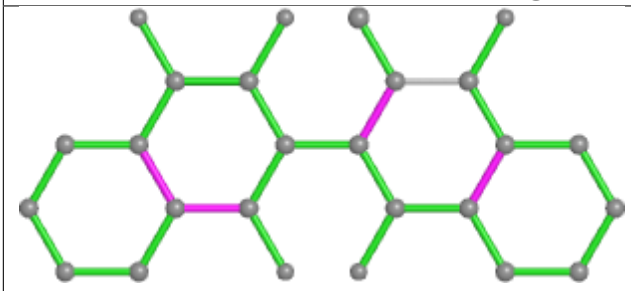


Torsions

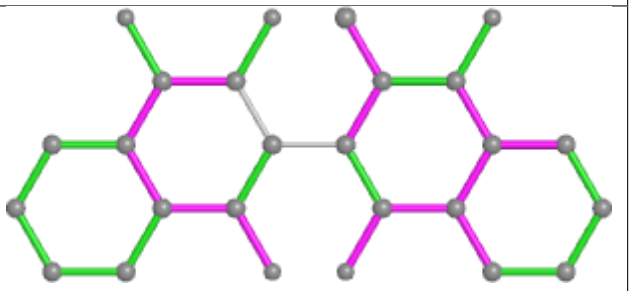


Rings

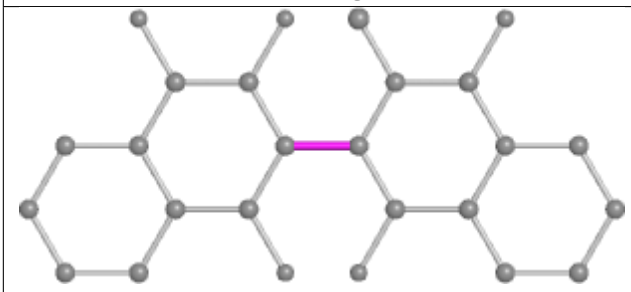
Ligand E6A B 302



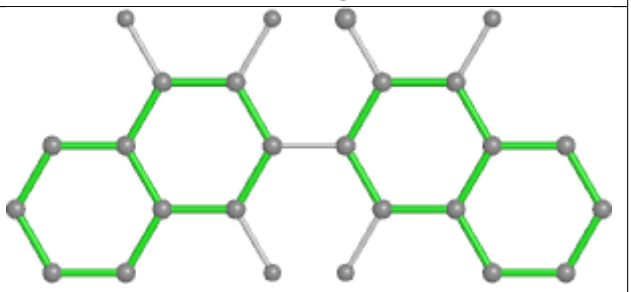
Bond lengths



Bond angles

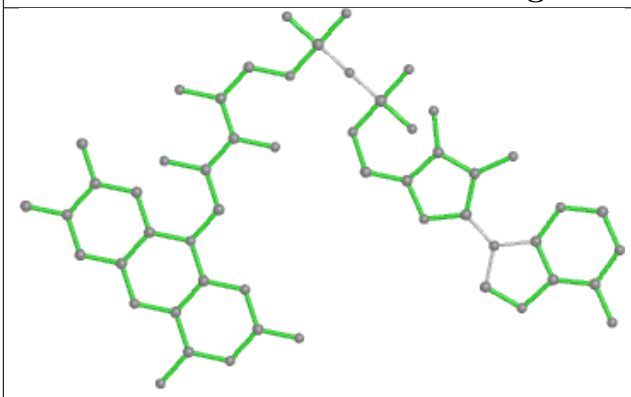


Torsions

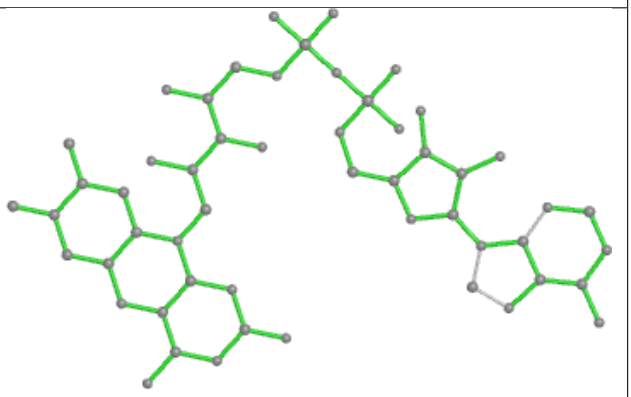


Rings

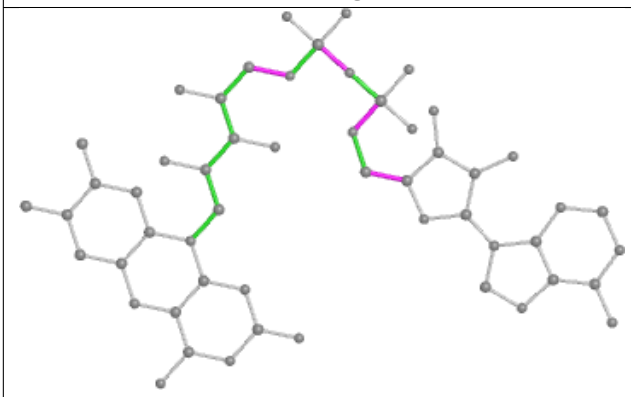
Ligand FAD L 301



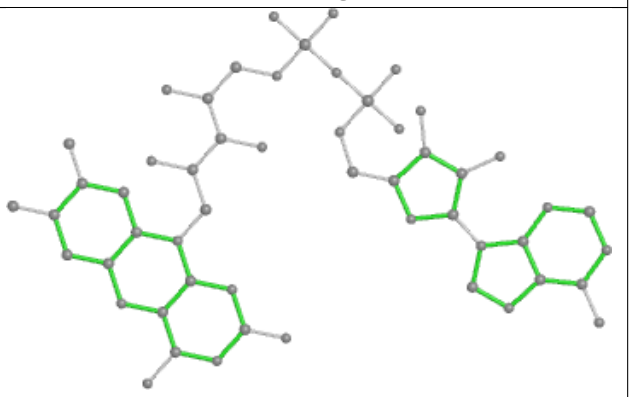
Bond lengths



Bond angles

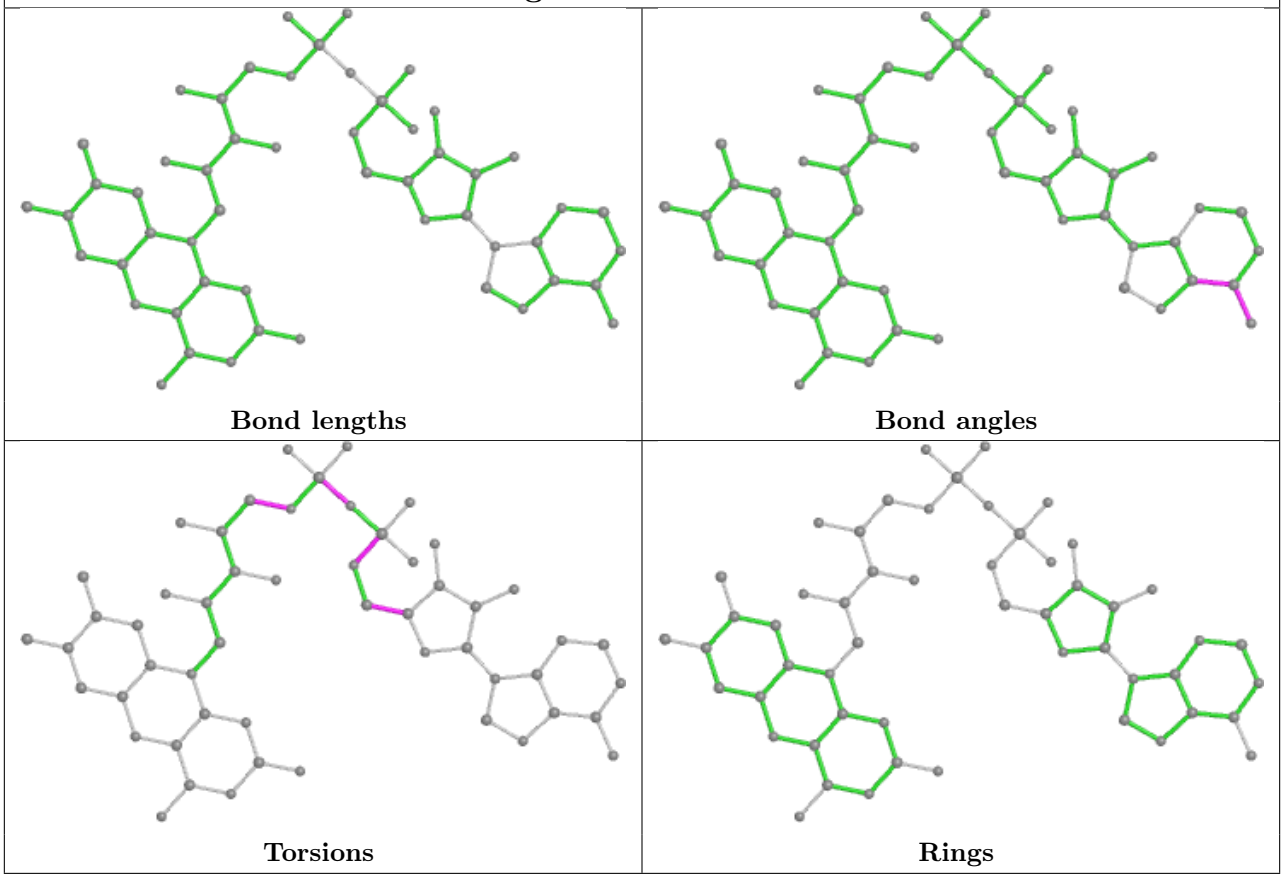


Torsions



Rings

Ligand FAD N 301



5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95^{th} percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å^2)	Q<0.9
1	A	270/277 (97%)	-0.11	0 100 100	47, 66, 90, 104	13 (4%)
1	B	269/277 (97%)	-0.07	1 (0%) 92 93	52, 74, 100, 114	17 (6%)
1	C	271/277 (97%)	-0.14	0 100 100	39, 62, 86, 109	13 (4%)
1	D	271/277 (97%)	-0.07	1 (0%) 92 93	44, 69, 99, 113	16 (5%)
1	E	271/277 (97%)	-0.07	1 (0%) 92 93	42, 62, 91, 109	16 (5%)
1	F	270/277 (97%)	-0.08	1 (0%) 92 93	45, 69, 96, 108	14 (5%)
1	G	272/277 (98%)	-0.06	2 (0%) 87 87	47, 78, 103, 134	21 (7%)
1	H	271/277 (97%)	0.04	1 (0%) 92 93	44, 71, 98, 112	23 (8%)
1	I	272/277 (98%)	-0.07	0 100 100	46, 67, 92, 102	9 (3%)
1	J	270/277 (97%)	-0.12	1 (0%) 92 93	45, 67, 95, 102	14 (5%)
1	K	271/277 (97%)	-0.01	3 (1%) 80 80	52, 76, 101, 116	20 (7%)
1	L	272/277 (98%)	-0.06	1 (0%) 92 93	46, 72, 101, 117	17 (6%)
1	M	272/277 (98%)	0.01	4 (1%) 73 73	52, 79, 101, 119	19 (6%)
1	N	271/277 (97%)	0.08	3 (1%) 80 80	50, 75, 103, 112	15 (5%)
All	All	3793/3878 (97%)	-0.05	19 (0%) 91 91	39, 71, 99, 134	227 (5%)

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	G	2	GLY	3.8
1	E	2	GLY	3.6
1	M	181	PHE	2.8
1	J	2	GLY	2.5
1	K	248	ASN	2.5

6.2 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates (i)

There are no monosaccharides in this entry.

6.4 Ligands (i)

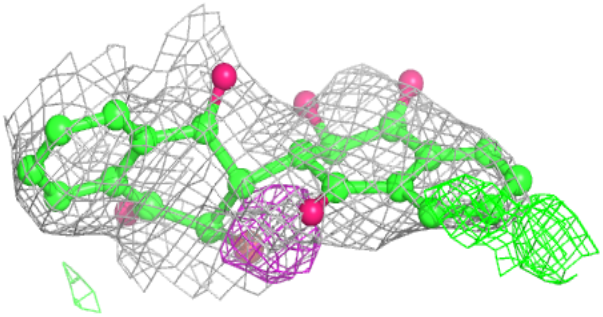
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

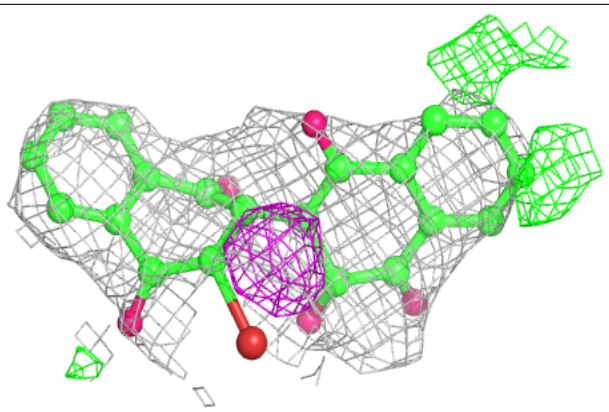
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	E6A	M	602	26/26	0.85	0.26	98,111,115,126	4
3	E6A	E	602	26/26	0.89	0.26	74,87,99,106	4
3	E6A	B	302	26/26	0.89	0.25	90,98,109,120	4
3	E6A	K	602	26/26	0.92	0.29	81,94,99,108	4
3	E6A	H	302	26/26	0.93	0.24	81,87,97,104	4
2	FAD	B	301	53/53	0.94	0.17	48,75,107,110	0
2	FAD	M	601	53/53	0.95	0.17	57,76,102,106	0
2	FAD	H	301	53/53	0.95	0.17	59,69,79,81	0
2	FAD	I	601	53/53	0.96	0.16	56,70,85,86	0
2	FAD	J	301	53/53	0.96	0.17	52,67,84,90	0
2	FAD	K	601	53/53	0.96	0.17	56,75,89,97	0
2	FAD	L	301	53/53	0.96	0.16	50,69,94,101	0
2	FAD	C	601	53/53	0.96	0.16	50,59,84,93	0
2	FAD	N	301	53/53	0.96	0.16	61,69,79,80	0
2	FAD	D	301	53/53	0.96	0.15	41,63,103,103	0
2	FAD	E	601	53/53	0.96	0.16	47,62,86,87	0
2	FAD	F	301	53/53	0.96	0.16	50,60,88,93	0
2	FAD	G	601	53/53	0.96	0.16	49,67,90,95	0
2	FAD	A	601	53/53	0.96	0.18	56,68,91,92	0

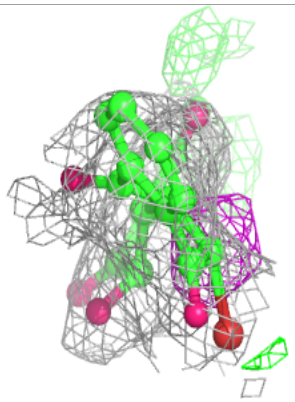
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around E6A M 602:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

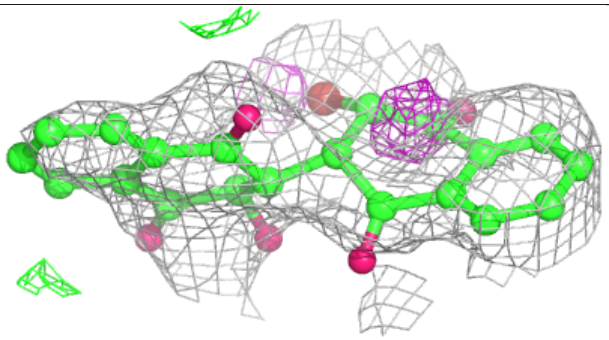


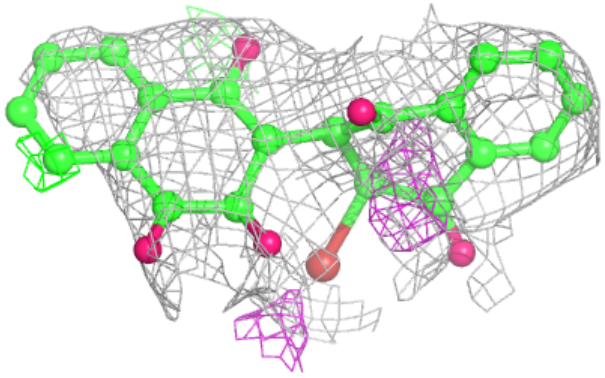


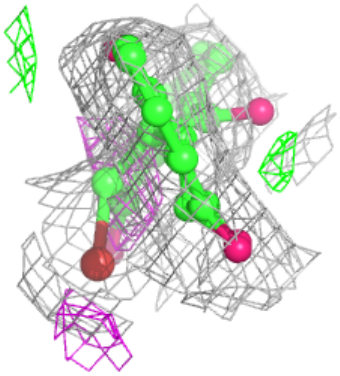


Electron density around E6A E 602:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

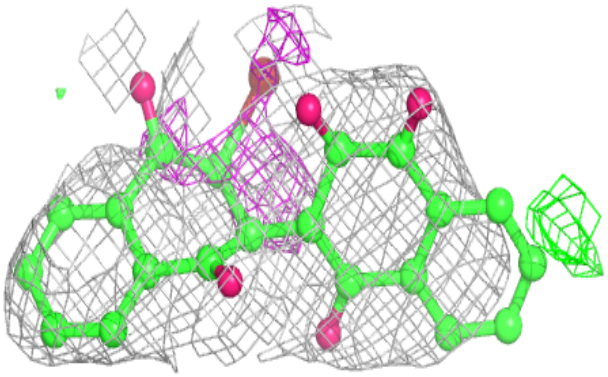


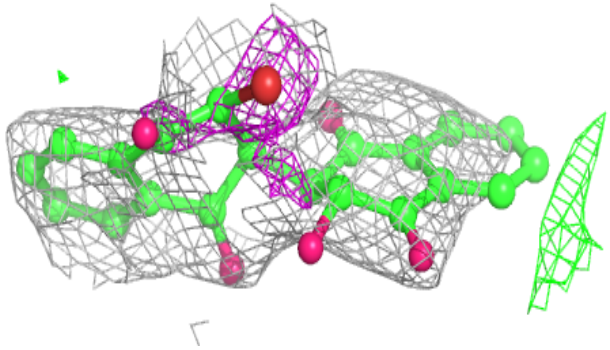


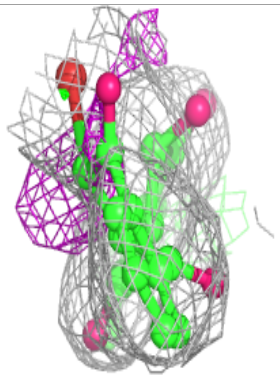


Electron density around E6A B 302:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

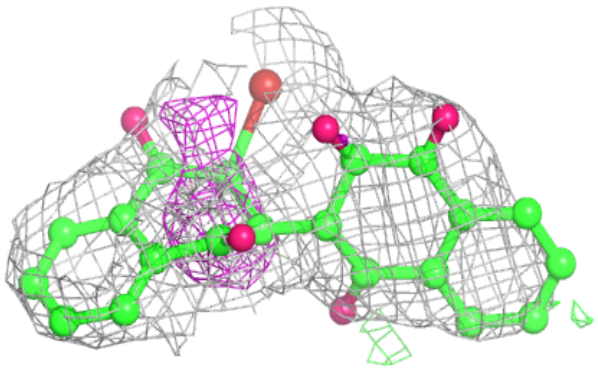


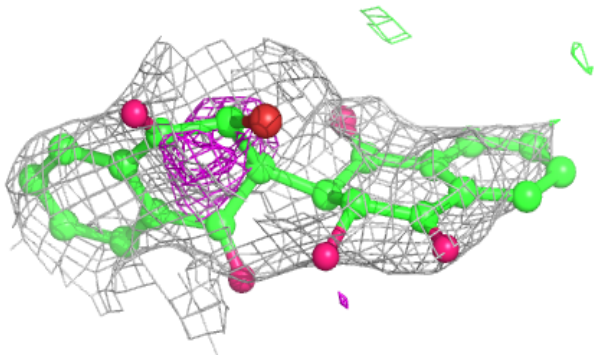


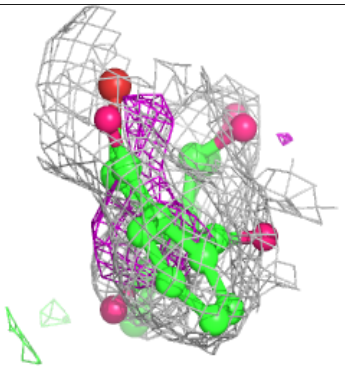


Electron density around E6A K 602:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

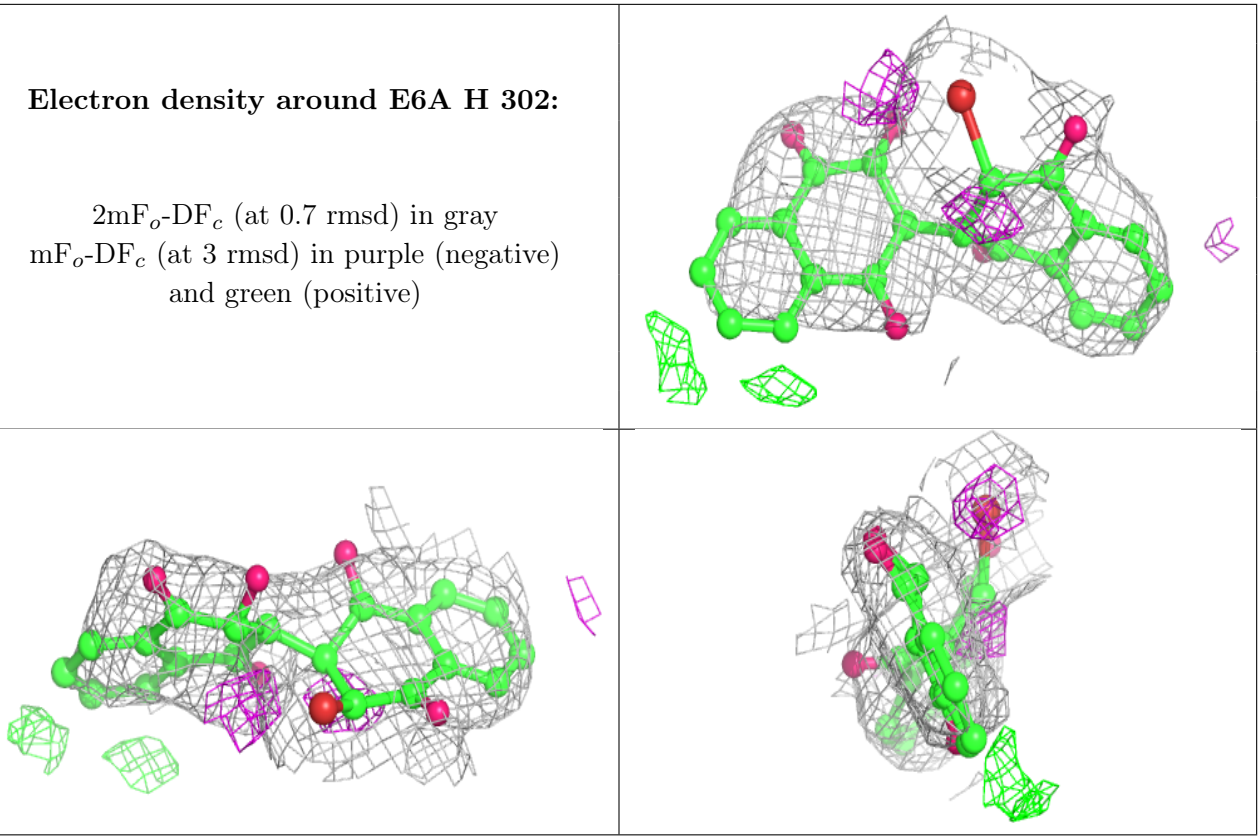






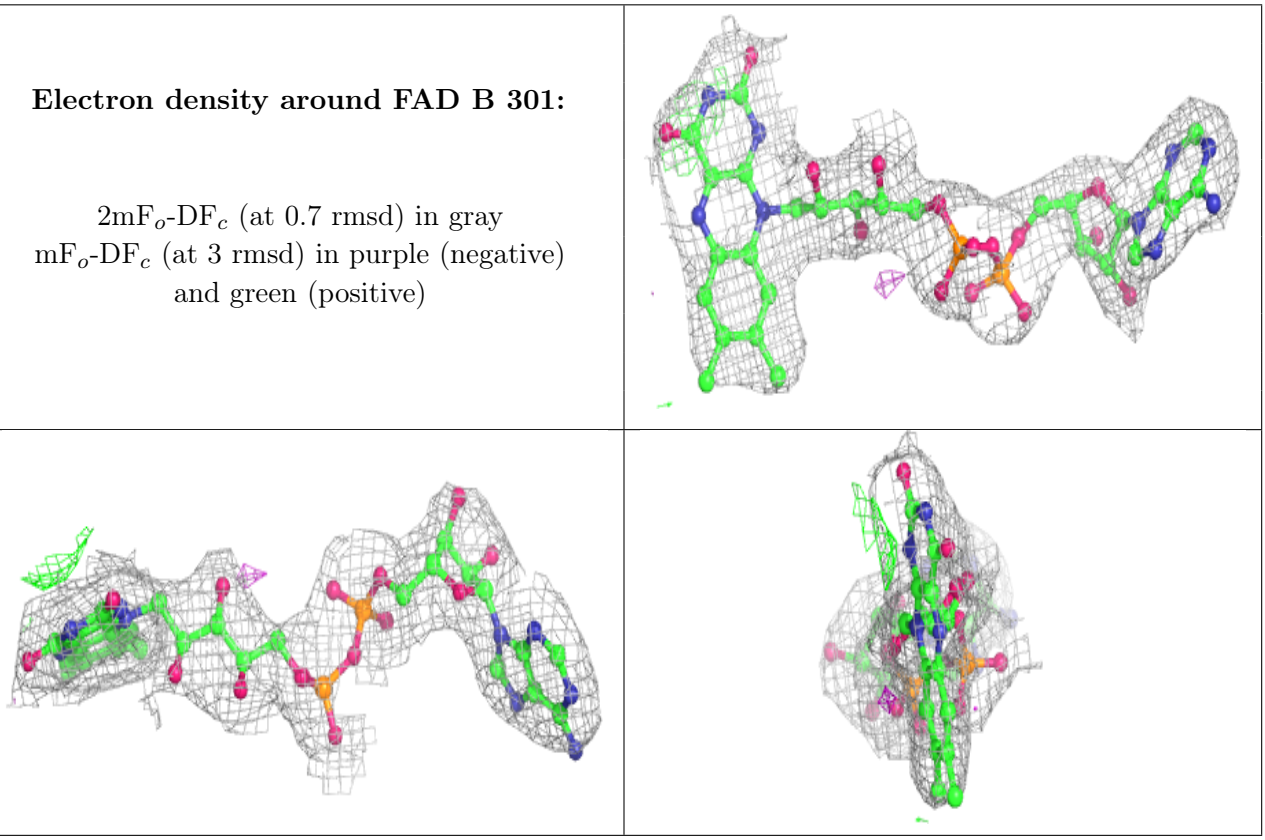
Electron density around E6A H 302:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)



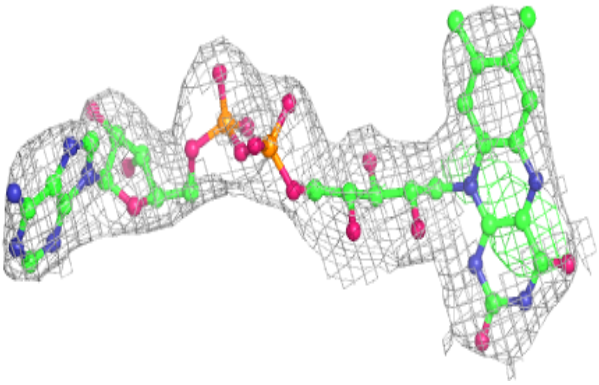
Electron density around FAD B 301:

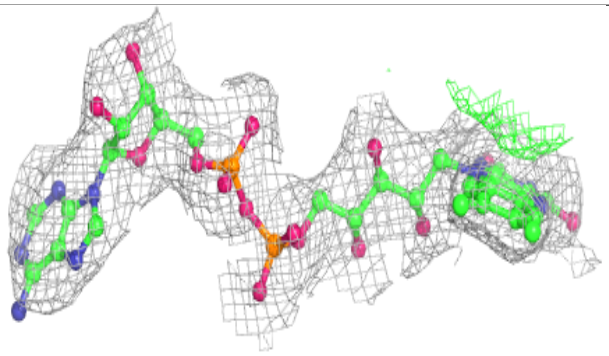
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

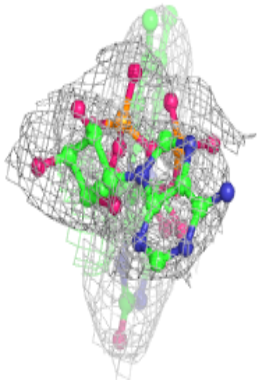


Electron density around FAD M 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

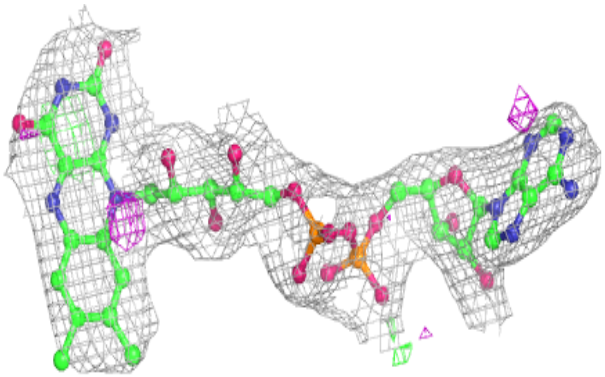


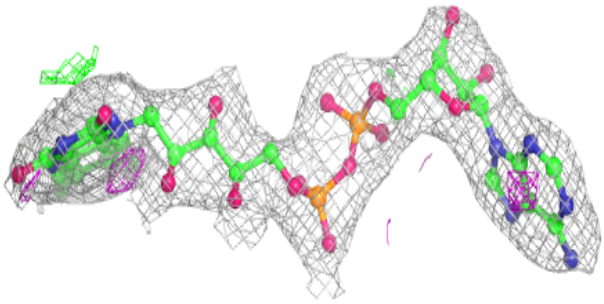


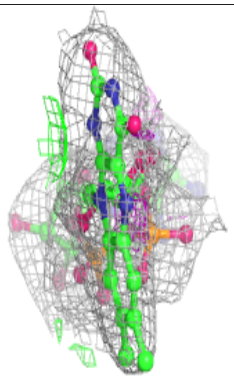


Electron density around FAD H 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

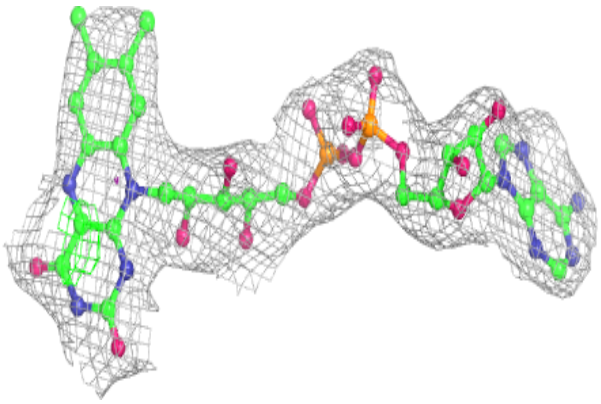


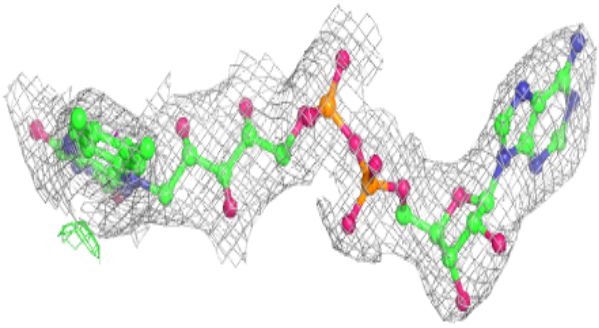


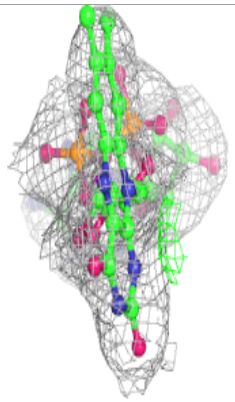


Electron density around FAD I 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

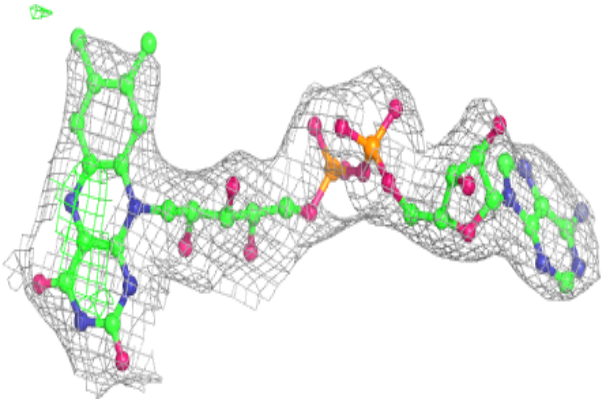


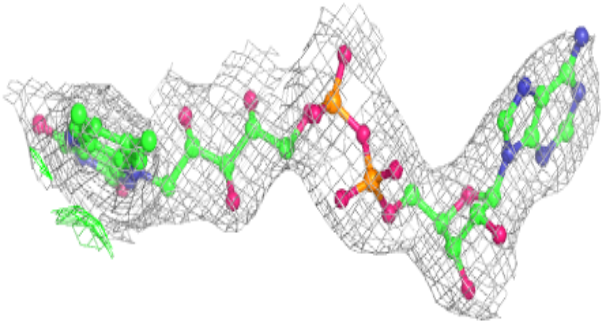


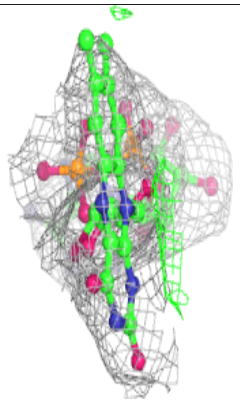


Electron density around FAD J 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

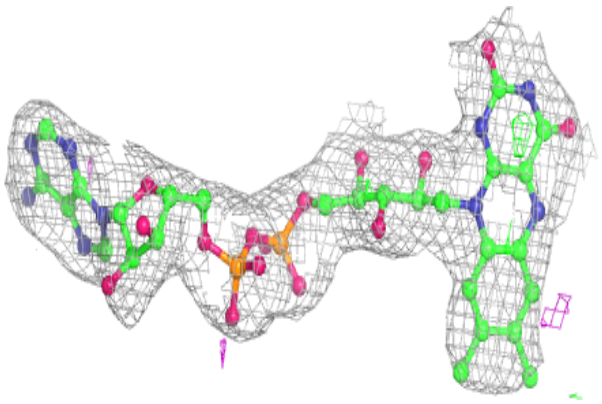


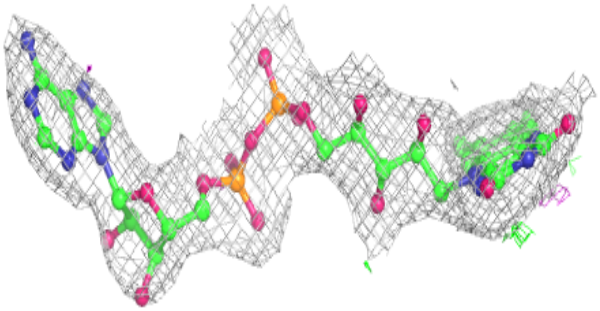


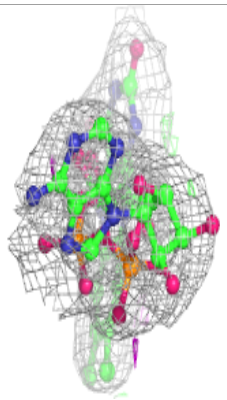


Electron density around FAD K 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

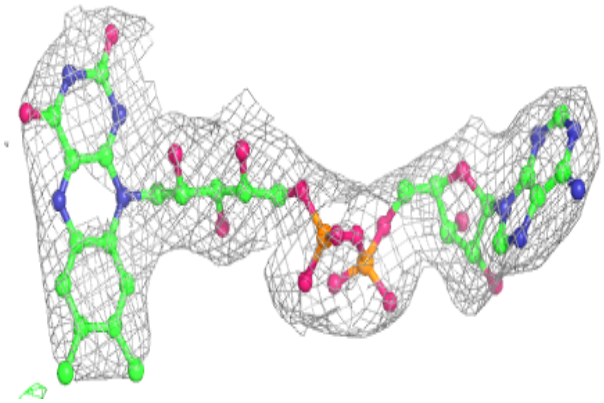


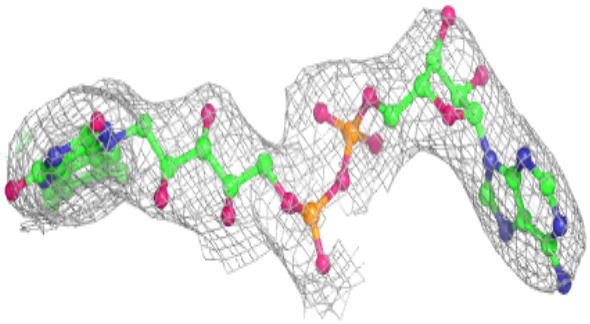


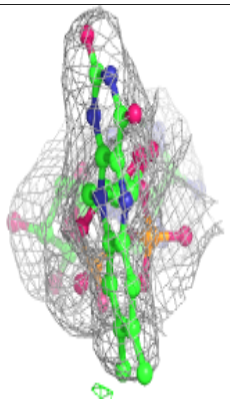


Electron density around FAD L 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

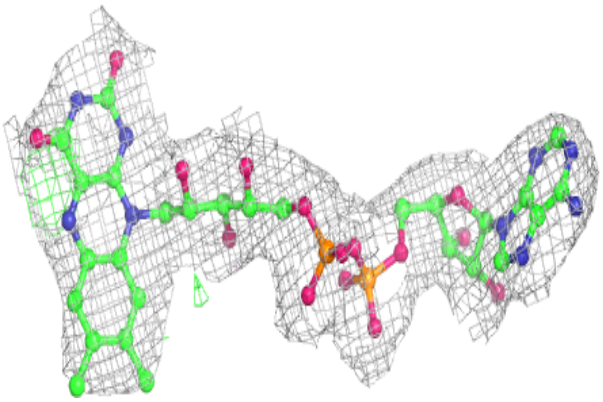


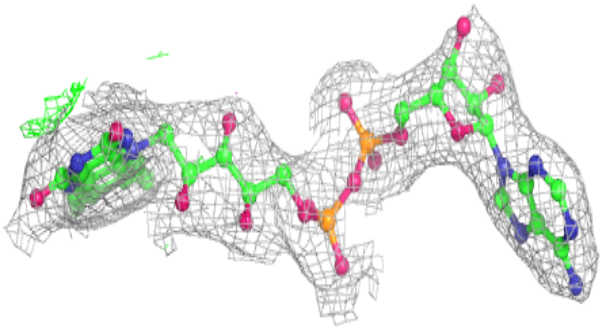


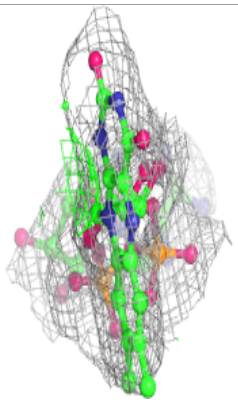


Electron density around FAD C 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

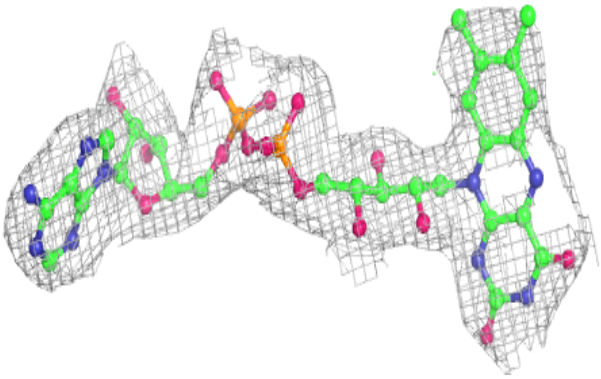


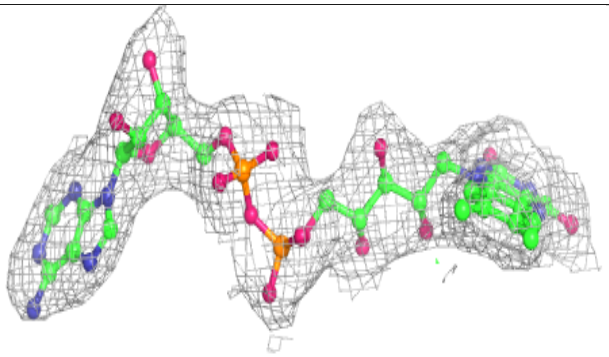


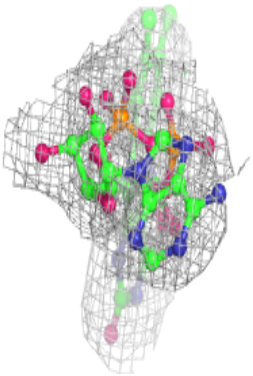


Electron density around FAD N 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

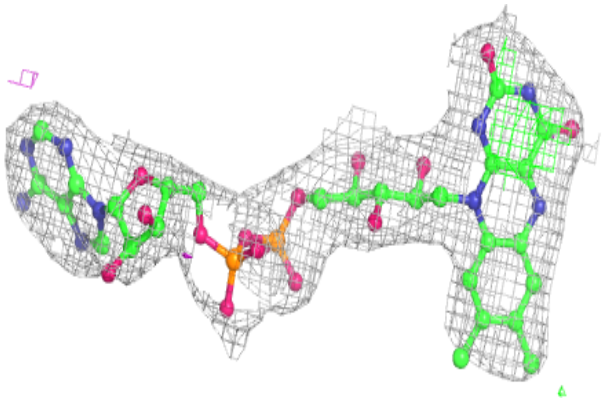


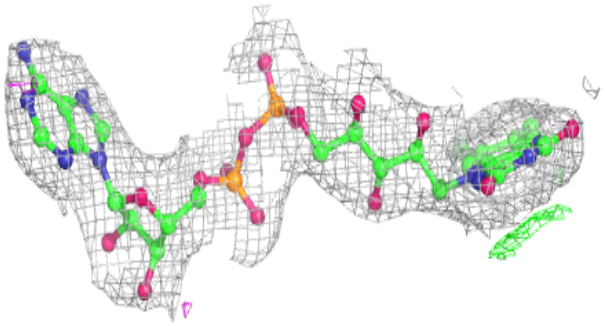


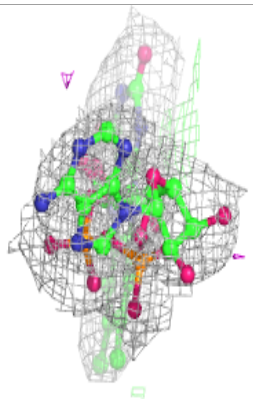


Electron density around FAD D 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

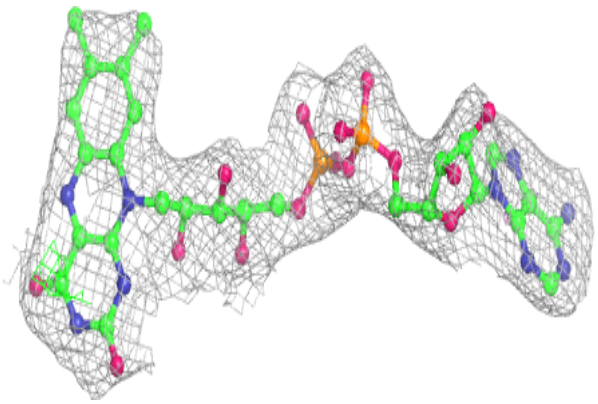


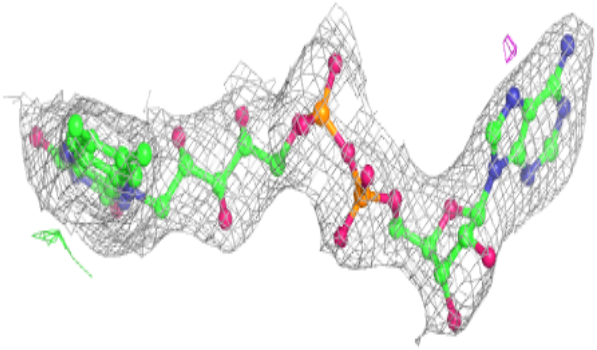


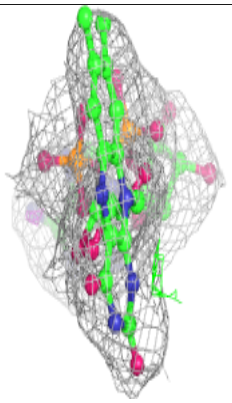


Electron density around FAD E 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

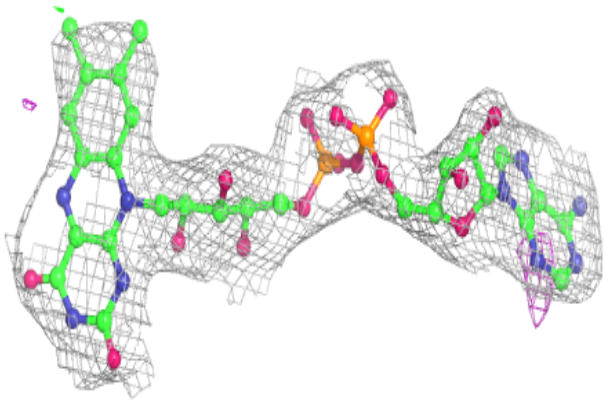


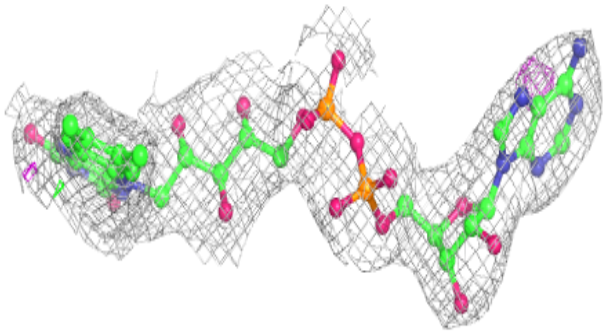


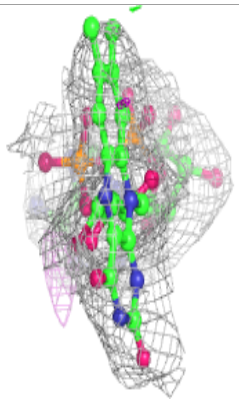


Electron density around FAD F 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

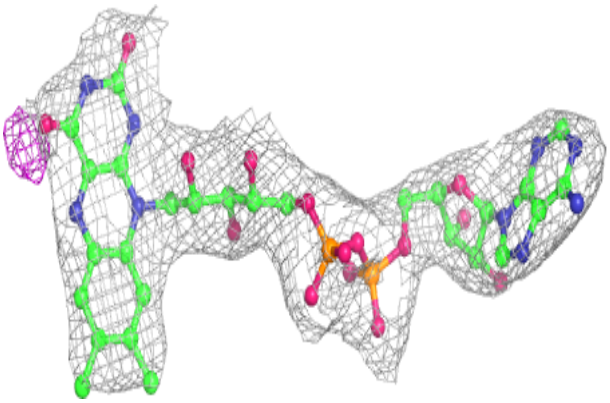


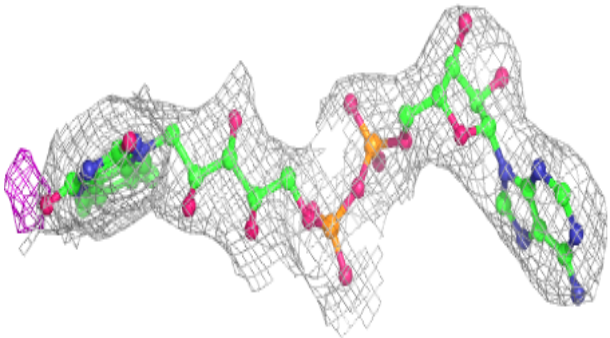


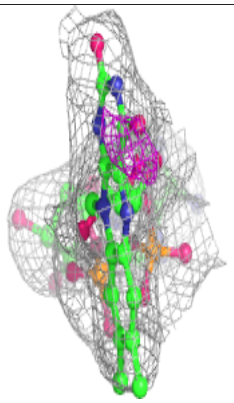


Electron density around FAD G 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)

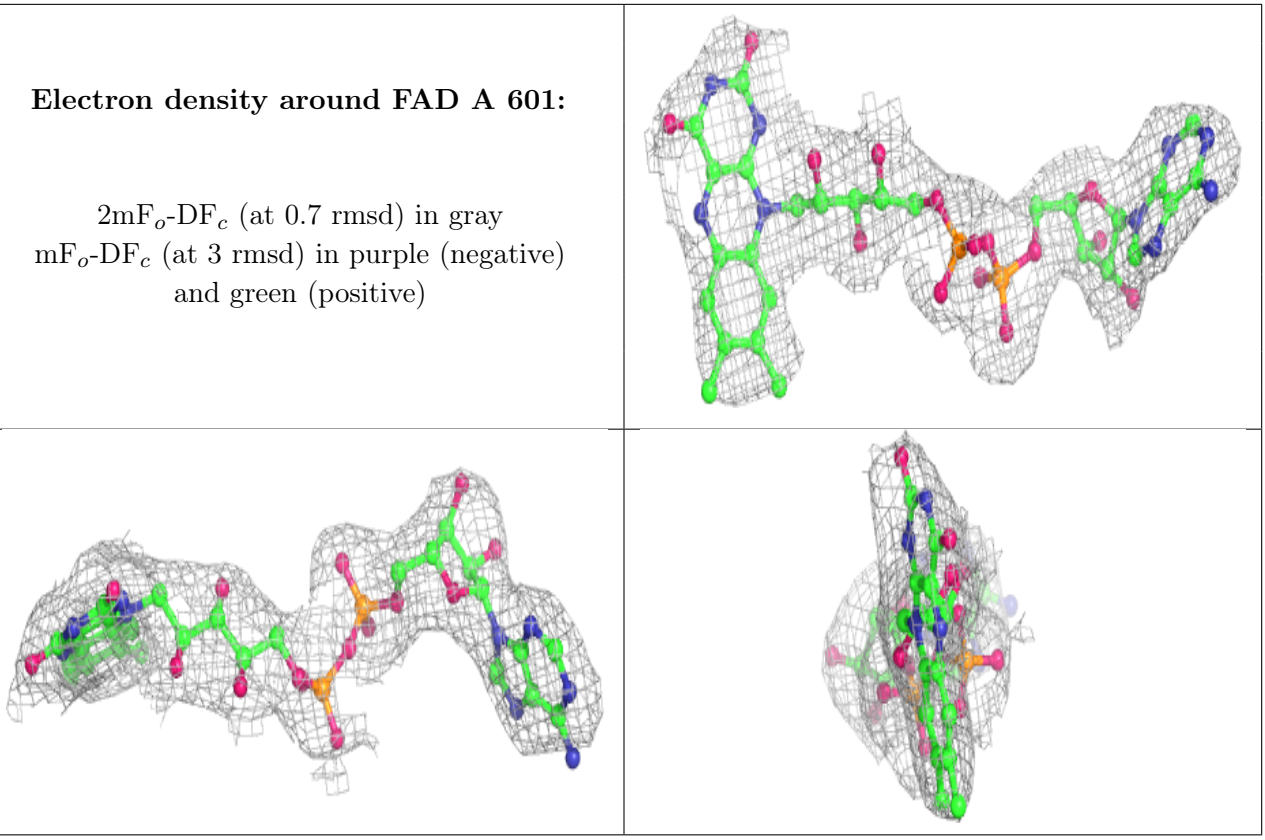






Electron density around FAD A 601:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative) and green (positive)



6.5 Other polymers (i)

There are no such residues in this entry.