



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 20, 2026 – 03:05 AM UTC

PDB ID : 2F5Z / pdb_00002f5z
Title : Crystal Structure of Human Dihydrolipoamide Dehydrogenase (E3) Complexed to the E3-Binding Domain of Human E3-Binding Protein
Authors : Brautigam, C.A.; Chuang, J.L.; Wynn, R.M.; Tomchick, D.R.; Machius, M.; Chuang, D.T.
Deposited on : 2005-11-28
Resolution : 2.18 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 ⓘ 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 ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

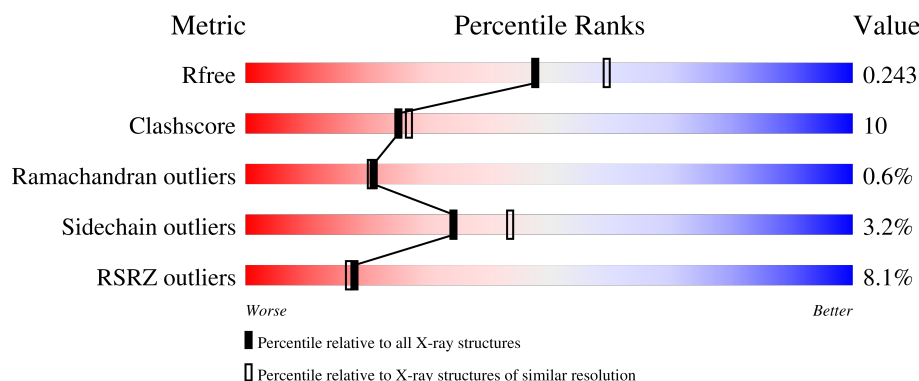
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.18 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}	180053	8975 (2.20-2.16)
Clashscore	190562	9786 (2.20-2.16)
Ramachandran outliers	187476	9664 (2.20-2.16)
Sidechain outliers	187428	9664 (2.20-2.16)
RSRZ outliers	180081	8979 (2.20-2.16)

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 $\leq 5\%$. 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	474	5% 76% 21% .
1	B	474	17% 70% 27% ..
1	C	474	3% 78% 20% .
1	D	474	2% 83% 15% ..

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Mol	Chain	Length	Quality of chain
1	E	474	
1	F	474	
1	G	474	
1	H	474	
1	I	474	
1	J	474	
2	K	64	
2	L	64	
2	M	64	
2	N	64	
2	O	64	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	SO4	B	2489	-	-	X	-
3	SO4	E	2499	-	-	X	-
3	SO4	H	2510	-	-	X	-
3	SO4	H	2511	-	-	X	-
3	SO4	I	2515	-	-	X	-
3	SO4	J	2520	-	-	X	-

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 40176 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 Dihydrolipoyl dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	472	Total	C	N	O	S	0	0	0
			3505	2208	606	672	19			
1	B	471	Total	C	N	O	S	0	0	0
			3496	2203	604	670	19			
1	C	472	Total	C	N	O	S	0	0	0
			3505	2208	606	672	19			
1	D	471	Total	C	N	O	S	0	0	0
			3496	2203	604	670	19			
1	E	472	Total	C	N	O	S	0	0	0
			3505	2208	606	672	19			
1	F	471	Total	C	N	O	S	0	0	0
			3496	2203	604	670	19			
1	G	472	Total	C	N	O	S	0	0	0
			3505	2208	606	672	19			
1	H	472	Total	C	N	O	S	0	0	0
			3505	2208	606	672	19			
1	I	470	Total	C	N	O	S	0	0	0
			3496	2204	604	669	19			
1	J	472	Total	C	N	O	S	0	0	0
			3505	2208	606	672	19			

- Molecule 2 is a protein called Pyruvate dehydrogenase protein X component.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	K	43	Total	C	N	O	0	0	0
			301	186	57	58			
2	L	43	Total	C	N	O	0	43	0
			590	364	112	114			
2	M	43	Total	C	N	O	0	43	0
			590	364	112	114			
2	N	43	Total	C	N	O	0	43	0
			590	364	112	114			

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	O	43	Total	C	N	O	0	43	0
			590	364	112	114			

There are 40 discrepancies between the modelled and reference sequences:

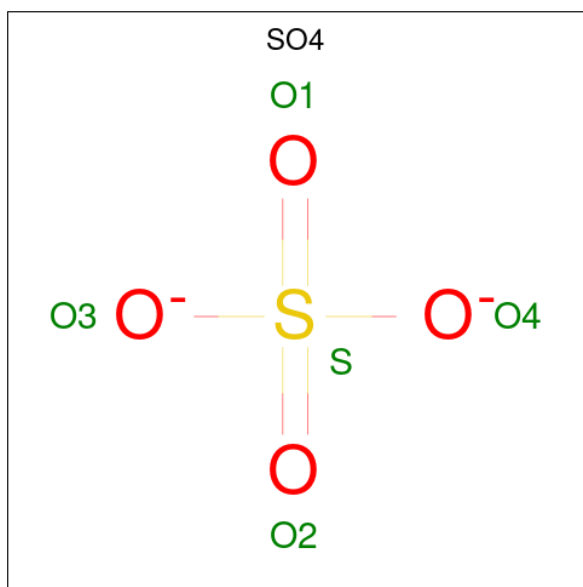
Chain	Residue	Modelled	Actual	Comment	Reference
K	120	GLY	LYS	engineered mutation	UNP O00330
K	176	LEU	THR	engineered mutation	UNP O00330
K	178	HIS	-	expression tag	UNP O00330
K	179	HIS	-	expression tag	UNP O00330
K	180	HIS	-	expression tag	UNP O00330
K	181	HIS	-	expression tag	UNP O00330
K	182	HIS	-	expression tag	UNP O00330
K	183	HIS	-	expression tag	UNP O00330
L	120	GLY	LYS	engineered mutation	UNP O00330
L	176	LEU	THR	engineered mutation	UNP O00330
L	178	HIS	-	expression tag	UNP O00330
L	179	HIS	-	expression tag	UNP O00330
L	180	HIS	-	expression tag	UNP O00330
L	181	HIS	-	expression tag	UNP O00330
L	182	HIS	-	expression tag	UNP O00330
L	183	HIS	-	expression tag	UNP O00330
M	120	GLY	LYS	engineered mutation	UNP O00330
M	176	LEU	THR	engineered mutation	UNP O00330
M	178	HIS	-	expression tag	UNP O00330
M	179	HIS	-	expression tag	UNP O00330
M	180	HIS	-	expression tag	UNP O00330
M	181	HIS	-	expression tag	UNP O00330
M	182	HIS	-	expression tag	UNP O00330
M	183	HIS	-	expression tag	UNP O00330
N	120	GLY	LYS	engineered mutation	UNP O00330
N	176	LEU	THR	engineered mutation	UNP O00330
N	178	HIS	-	expression tag	UNP O00330
N	179	HIS	-	expression tag	UNP O00330
N	180	HIS	-	expression tag	UNP O00330
N	181	HIS	-	expression tag	UNP O00330
N	182	HIS	-	expression tag	UNP O00330
N	183	HIS	-	expression tag	UNP O00330
O	120	GLY	LYS	engineered mutation	UNP O00330
O	176	LEU	THR	engineered mutation	UNP O00330
O	178	HIS	-	expression tag	UNP O00330
O	179	HIS	-	expression tag	UNP O00330

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Chain	Residue	Modelled	Actual	Comment	Reference
O	180	HIS	-	expression tag	UNP O00330
O	181	HIS	-	expression tag	UNP O00330
O	182	HIS	-	expression tag	UNP O00330
O	183	HIS	-	expression tag	UNP O00330

- Molecule 3 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	O	S	0	0
			5	4	1		
3	A	1	Total	O	S	0	0
			5	4	1		
3	A	1	Total	O	S	0	0
			5	4	1		
3	A	1	Total	O	S	0	0
			5	4	1		
3	B	1	Total	O	S	0	0
			5	4	1		
3	B	1	Total	O	S	0	0
			5	4	1		
3	B	1	Total	O	S	0	0
			5	4	1		
3	B	1	Total	O	S	0	0
			5	4	1		
3	C	1	Total	O	S	0	0
			5	4	1		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	C	1	Total	O	S	0	0
			5	4	1		
3	C	1	Total	O	S	0	0
			5	4	1		
3	C	1	Total	O	S	0	0
			5	4	1		
3	D	1	Total	O	S	0	0
			5	4	1		
3	D	1	Total	O	S	0	0
			5	4	1		
3	D	1	Total	O	S	0	0
			5	4	1		
3	D	1	Total	O	S	0	0
			5	4	1		
3	E	1	Total	O	S	0	0
			5	4	1		
3	E	1	Total	O	S	0	0
			5	4	1		
3	E	1	Total	O	S	0	0
			5	4	1		
3	E	1	Total	O	S	0	0
			5	4	1		
3	F	1	Total	O	S	0	0
			5	4	1		
3	F	1	Total	O	S	0	0
			5	4	1		
3	F	1	Total	O	S	0	0
			5	4	1		
3	F	1	Total	O	S	0	0
			5	4	1		
3	G	1	Total	O	S	0	0
			5	4	1		
3	G	1	Total	O	S	0	0
			5	4	1		
3	G	1	Total	O	S	0	0
			5	4	1		
3	G	1	Total	O	S	0	0
			5	4	1		
3	H	1	Total	O	S	0	0
			5	4	1		
3	H	1	Total	O	S	0	0
			5	4	1		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	H	1	Total 5	O 4	S 1	0	0
3	H	1	Total 5	O 4	S 1	0	0
3	I	1	Total 5	O 4	S 1	0	0
3	I	1	Total 5	O 4	S 1	0	0
3	I	1	Total 5	O 4	S 1	0	0
3	J	1	Total 5	O 4	S 1	0	0
3	J	1	Total 5	O 4	S 1	0	0
3	J	1	Total 5	O 4	S 1	0	0
3	J	1	Total 5	O 4	S 1	0	0

- # FAD

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

WORLDWIDE
 **PDB**
PROTEIN DATA BANK

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

- Molecule 5 is water.

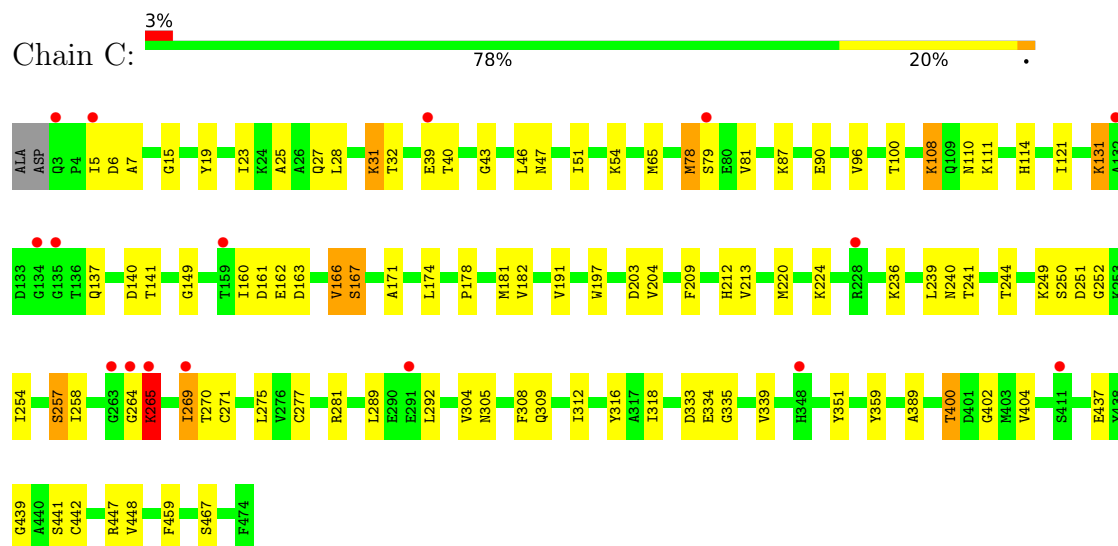
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	183	Total	O	0	0
			183	183		
5	B	101	Total	O	0	0
			101	101		
5	C	172	Total	O	0	0
			172	172		
5	D	243	Total	O	0	0
			243	243		
5	E	150	Total	O	0	0
			150	150		
5	F	217	Total	O	0	0
			217	217		
5	G	188	Total	O	0	0
			188	188		
5	H	315	Total	O	0	0
			315	315		
5	I	73	Total	O	0	0
			73	73		
5	J	132	Total	O	0	0
			132	132		
5	N	1	Total	O	0	0
			1	1		

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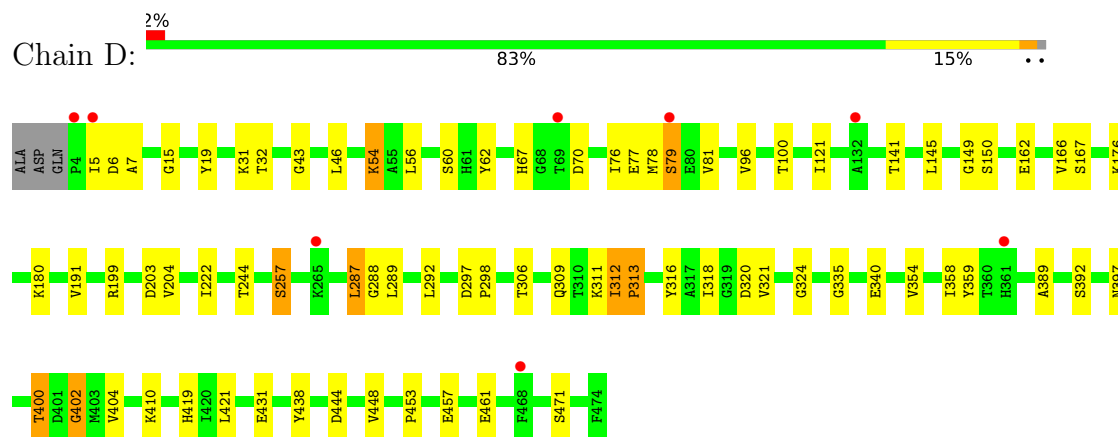
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	O	1	Total	O	0	0
			1	1		

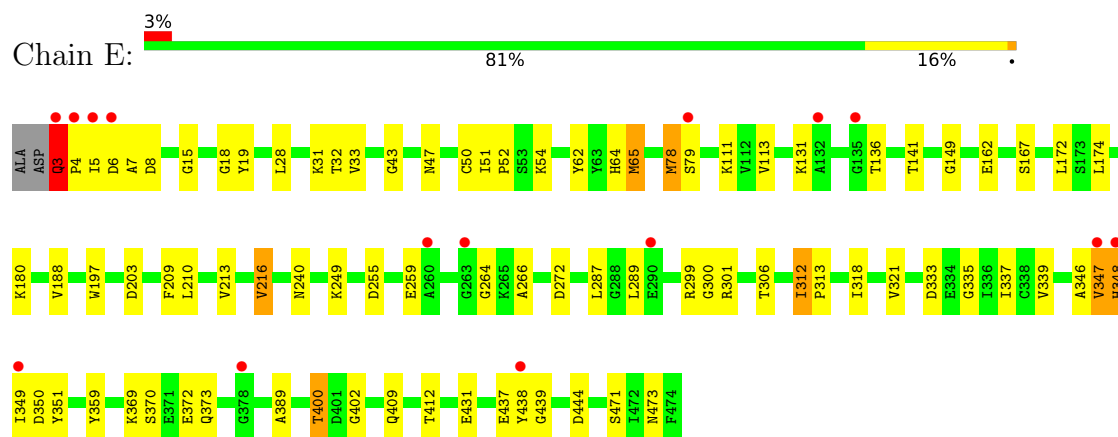
- Molecule 1: Dihydrolipoyl dehydrogenase



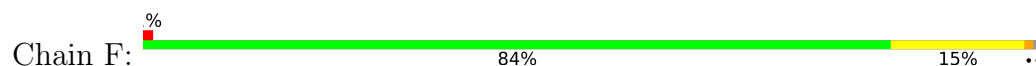
- Molecule 1: Dihydrolipoyl dehydrogenase

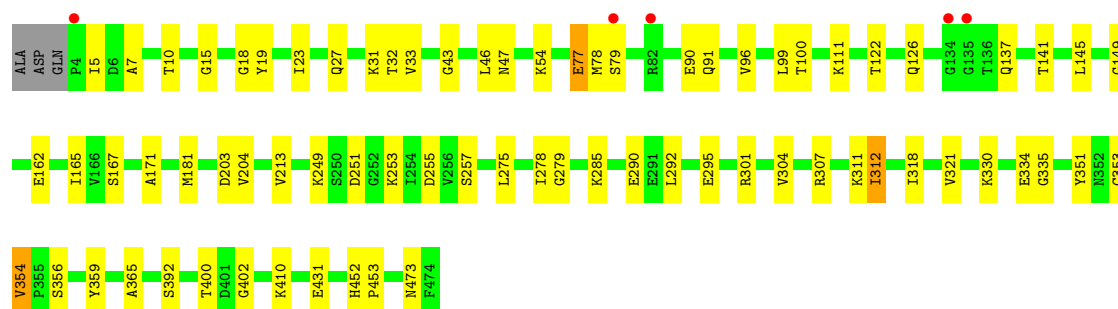


- Molecule 1: Dihydrolipoyl dehydrogenase

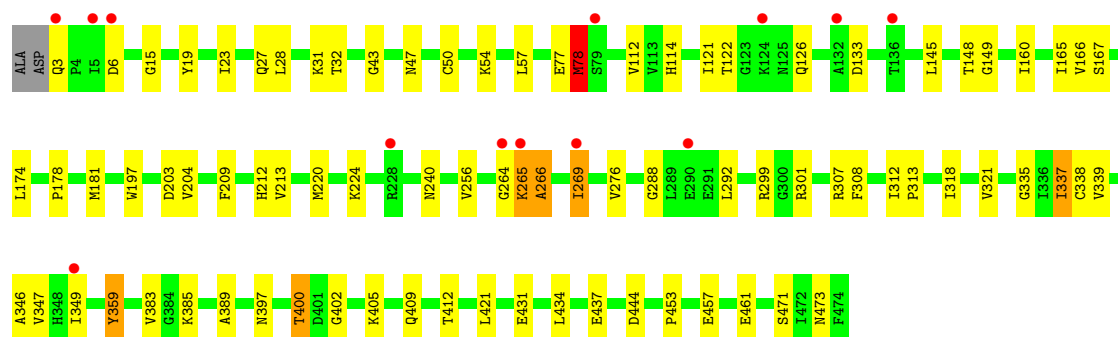
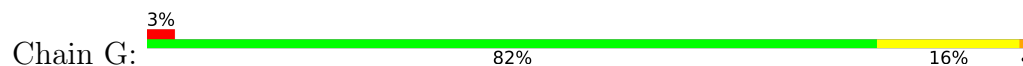


- Molecule 1: Dihydrolipoyl dehydrogenase

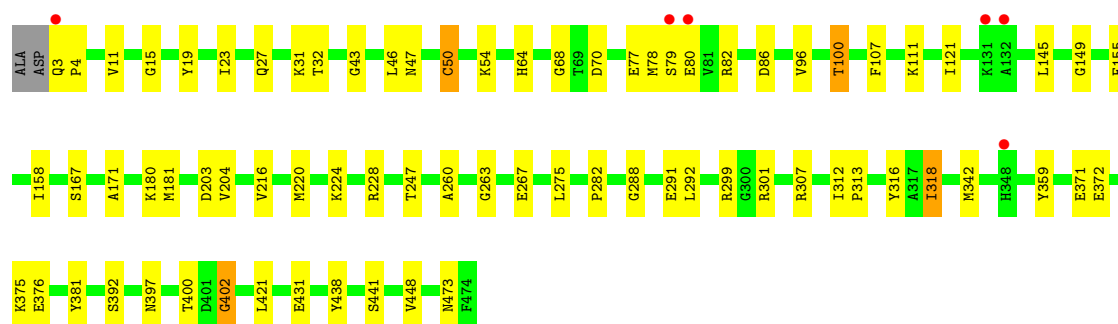
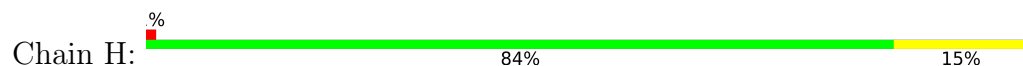




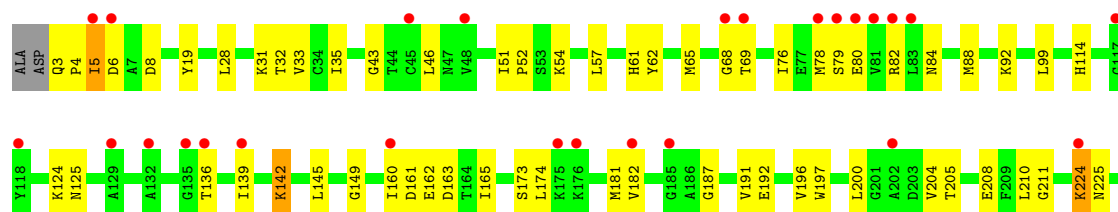
• Molecule 1: Dihydrolipoyl dehydrogenase

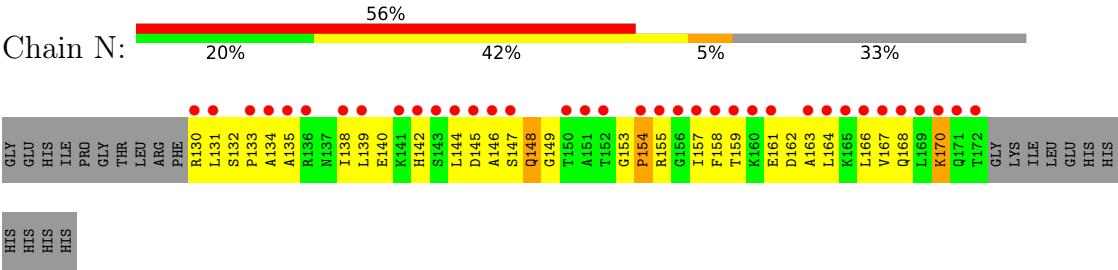


• Molecule 1: Dihydrolipoyl dehydrogenase

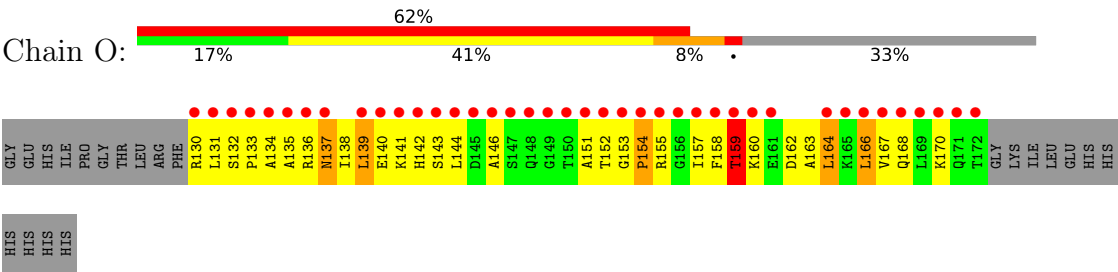


• Molecule 1: Dihydrolipoyl dehydrogenase





● Molecule 2: Pyruvate dehydrogenase protein X component



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	171.15Å 187.73Å 224.39Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	37.40 – 2.18 37.40 – 2.18	Depositor EDS
% Data completeness (in resolution range)	98.1 (37.40-2.18) 98.2 (37.40-2.18)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.05	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.79 (at 2.18Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.205 , 0.242 0.207 , 0.243	Depositor DCC
R_{free} test set	4523 reflections (1.23%)	wwPDB-VP
Wilson B-factor (Å ²)	35.9	Xtriage
Anisotropy	0.311	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 44.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	40176	wwPDB-VP
Average B, all atoms (Å ²)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.16% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ 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: SO4, FAD

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	0.58	0/3560	1.03	21/4809 (0.4%)
1	B	0.52	1/3551 (0.0%)	1.02	17/4796 (0.4%)
1	C	0.64	0/3560	1.08	19/4809 (0.4%)
1	D	0.67	0/3551	1.07	20/4796 (0.4%)
1	E	0.62	1/3560 (0.0%)	1.04	21/4809 (0.4%)
1	F	0.68	1/3551 (0.0%)	1.08	21/4796 (0.4%)
1	G	0.63	1/3560 (0.0%)	1.05	17/4809 (0.4%)
1	H	0.76	1/3560 (0.0%)	1.08	23/4809 (0.5%)
1	I	0.54	0/3550	1.02	17/4796 (0.4%)
1	J	0.62	0/3560	1.03	23/4809 (0.5%)
2	K	0.42	0/304	1.19	6/411 (1.5%)
2	L	0.29	0/596	0.78	2/808 (0.2%)
2	M	0.30	0/596	0.69	0/808
2	N	0.29	0/596	0.60	0/808
2	O	0.31	0/596	0.79	0/808
All	All	0.61	5/38251 (0.0%)	1.03	207/51681 (0.4%)

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	H	181	MET	SD-CE	-6.41	1.63	1.79
1	G	78	MET	SD-CE	-6.08	1.64	1.79
1	B	65	MET	SD-CE	-5.69	1.65	1.79
1	F	181	MET	SD-CE	-5.54	1.65	1.79
1	E	65	MET	SD-CE	-5.49	1.65	1.79

The worst 5 of 207 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	F	400	THR	N-CA-C	10.47	125.36	112.59

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	G	400	THR	N-CA-C	10.14	125.97	112.88
1	I	312	ILE	CA-C-N	9.65	131.90	119.84
1	I	312	ILE	C-N-CA	9.65	131.90	119.84
1	E	400	THR	N-CA-C	9.38	124.03	112.59

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

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	3505	0	3556	69	0
1	B	3496	0	3549	105	0
1	C	3505	0	3556	59	0
1	D	3496	0	3549	45	0
1	E	3505	0	3556	63	0
1	F	3496	0	3549	39	0
1	G	3505	0	3556	48	0
1	H	3505	0	3556	41	0
1	I	3496	0	3549	81	0
1	J	3505	0	3556	61	0
2	K	301	0	289	17	0
2	L	590	0	546	40	0
2	M	590	0	546	38	0
2	N	590	0	546	47	0
2	O	590	0	546	58	0
3	A	20	0	0	2	0
3	B	20	0	0	4	0
3	C	20	0	0	1	0
3	D	20	0	0	0	0
3	E	20	0	0	3	0
3	F	20	0	0	2	0
3	G	20	0	0	1	0
3	H	20	0	0	4	0
3	I	15	0	0	3	0
3	J	20	0	0	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	A	53	0	31	2	0
4	B	53	0	31	2	0
4	C	53	0	31	3	0
4	D	53	0	31	2	0
4	E	53	0	31	2	0
4	F	53	0	31	4	0
4	G	53	0	31	2	0
4	H	53	0	31	5	0
4	I	53	0	31	1	0
4	J	53	0	31	3	0
5	A	183	0	0	0	0
5	B	101	0	0	3	0
5	C	172	0	0	2	0
5	D	243	0	0	2	0
5	E	150	0	0	2	0
5	F	217	0	0	4	0
5	G	188	0	0	1	0
5	H	315	0	0	5	0
5	I	73	0	0	4	0
5	J	132	0	0	0	0
5	N	1	0	0	1	0
5	O	1	0	0	0	0
All	All	40176	0	38315	747	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 10.

The worst 5 of 747 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:I:290:GLU:HB3	3:I:2516:SO4:O4	1.54	1.07
1:A:461:GLU:HG2	1:A:471:SER:HB2	1.37	1.02
1:G:337:ILE:HG12	1:G:349:ILE:HD11	1.37	1.02
1:B:144:ILE:HB	1:B:315:ILE:HD13	1.39	1.01
1:C:178:PRO:HG3	1:C:181:MET:HE3	1.49	0.92

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	470/474 (99%)	445 (95%)	23 (5%)	2 (0%)	30	31
1	B	469/474 (99%)	440 (94%)	27 (6%)	2 (0%)	30	31
1	C	470/474 (99%)	455 (97%)	13 (3%)	2 (0%)	30	31
1	D	469/474 (99%)	456 (97%)	11 (2%)	2 (0%)	30	31
1	E	470/474 (99%)	451 (96%)	17 (4%)	2 (0%)	30	31
1	F	469/474 (99%)	452 (96%)	17 (4%)	0	100	100
1	G	470/474 (99%)	456 (97%)	11 (2%)	3 (1%)	21	20
1	H	470/474 (99%)	459 (98%)	10 (2%)	1 (0%)	43	49
1	I	466/474 (98%)	438 (94%)	26 (6%)	2 (0%)	30	31
1	J	470/474 (99%)	452 (96%)	16 (3%)	2 (0%)	30	31
2	K	41/64 (64%)	35 (85%)	6 (15%)	0	100	100
2	L	82/64 (128%)	68 (83%)	6 (7%)	8 (10%)	0	0
2	M	82/64 (128%)	64 (78%)	14 (17%)	4 (5%)	1	0
2	N	82/64 (128%)	60 (73%)	16 (20%)	6 (7%)	1	0
2	O	82/64 (128%)	68 (83%)	8 (10%)	6 (7%)	1	0
All	All	5062/5060 (100%)	4799 (95%)	221 (4%)	42 (1%)	21	14

5 of 42 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	349	ILE
1	D	79	SER
1	E	348	HIS
1	G	265	LYS
1	H	79	SER

5.3.2 Protein sidechains ⓘ

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	372/373 (100%)	359 (96%)	13 (4%)	32	40
1	B	371/373 (100%)	360 (97%)	11 (3%)	36	46
1	C	372/373 (100%)	360 (97%)	12 (3%)	34	43
1	D	371/373 (100%)	361 (97%)	10 (3%)	39	50
1	E	372/373 (100%)	361 (97%)	11 (3%)	36	46
1	F	371/373 (100%)	357 (96%)	14 (4%)	29	37
1	G	372/373 (100%)	362 (97%)	10 (3%)	39	50
1	H	372/373 (100%)	361 (97%)	11 (3%)	36	46
1	I	372/373 (100%)	357 (96%)	15 (4%)	28	35
1	J	372/373 (100%)	364 (98%)	8 (2%)	45	58
2	K	28/53 (53%)	27 (96%)	1 (4%)	31	39
2	L	52/53 (98%)	50 (96%)	2 (4%)	29	37
2	M	52/53 (98%)	48 (92%)	4 (8%)	12	12
2	N	52/53 (98%)	50 (96%)	2 (4%)	29	37
2	O	52/53 (98%)	42 (81%)	10 (19%)	1	1
All	All	3953/3995 (99%)	3819 (97%)	134 (3%)	34	41

5 of 134 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	K	139	LEU
2	M	138[B]	ILE
2	O	164[A]	LEU
1	E	50	CYS
1	E	19	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 67 such sidechains are listed below:

Mol	Chain	Res	Type
1	G	409	GLN
1	H	240	ASN
1	J	240	ASN
1	C	231	GLN
1	C	227	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

49 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	SO4	B	2487	-	4,4,4	0.72	0	6,6,6	0.09	0
3	SO4	G	2508	-	4,4,4	0.70	0	6,6,6	0.07	0
3	SO4	G	2509	-	4,4,4	0.71	0	6,6,6	0.07	0
4	FAD	E	480	-	58,58,58	1.36	8 (13%)	85,89,89	1.03	5 (5%)
3	SO4	J	2520	-	4,4,4	0.70	0	6,6,6	0.09	0
3	SO4	H	2511	-	4,4,4	0.71	0	6,6,6	0.11	0
3	SO4	J	2519	-	4,4,4	0.71	0	6,6,6	0.07	0
3	SO4	I	2515	-	4,4,4	0.70	0	6,6,6	0.08	0
3	SO4	B	2489	-	4,4,4	0.70	0	6,6,6	0.08	0
3	SO4	E	2501	-	4,4,4	0.70	0	6,6,6	0.09	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
3	SO4	F	2505	-	4,4,4	0.72	0	6,6,6	0.08	0
4	FAD	G	480	-	58,58,58	1.34	8 (13%)	85,89,89	1.09	8 (9%)
4	FAD	F	480	-	58,58,58	1.64	11 (18%)	85,89,89	1.08	4 (4%)
3	SO4	A	2482	-	4,4,4	0.70	0	6,6,6	0.07	0
3	SO4	A	2483	-	4,4,4	0.69	0	6,6,6	0.10	0
3	SO4	A	2485	-	4,4,4	0.70	0	6,6,6	0.07	0
3	SO4	C	2493	-	4,4,4	0.71	0	6,6,6	0.08	0
4	FAD	C	480	-	58,58,58	1.28	6 (10%)	85,89,89	1.11	8 (9%)
3	SO4	E	2500	-	4,4,4	0.71	0	6,6,6	0.10	0
4	FAD	J	480	-	58,58,58	1.19	6 (10%)	85,89,89	1.09	5 (5%)
3	SO4	J	2517	-	4,4,4	0.71	0	6,6,6	0.10	0
3	SO4	G	2507	-	4,4,4	0.69	0	6,6,6	0.09	0
3	SO4	D	2494	-	4,4,4	0.70	0	6,6,6	0.10	0
4	FAD	D	480	-	58,58,58	1.34	8 (13%)	85,89,89	1.11	6 (7%)
3	SO4	B	2488	-	4,4,4	0.70	0	6,6,6	0.09	0
3	SO4	C	2490	-	4,4,4	0.69	0	6,6,6	0.11	0
3	SO4	F	2502	-	4,4,4	0.70	0	6,6,6	0.10	0
3	SO4	E	2498	-	4,4,4	0.70	0	6,6,6	0.09	0
3	SO4	D	2496	-	4,4,4	0.71	0	6,6,6	0.08	0
3	SO4	F	2504	-	4,4,4	0.69	0	6,6,6	0.12	0
3	SO4	H	2513	-	4,4,4	0.72	0	6,6,6	0.06	0
3	SO4	B	2486	-	4,4,4	0.70	0	6,6,6	0.08	0
3	SO4	C	2492	-	4,4,4	0.71	0	6,6,6	0.06	0
4	FAD	I	480	-	58,58,58	1.35	6 (10%)	85,89,89	1.07	7 (8%)
3	SO4	C	2491	-	4,4,4	0.70	0	6,6,6	0.12	0
3	SO4	I	2516	-	4,4,4	0.70	0	6,6,6	0.06	0
3	SO4	D	2495	-	4,4,4	0.70	0	6,6,6	0.11	0
3	SO4	G	2506	-	4,4,4	0.70	0	6,6,6	0.06	0
3	SO4	H	2510	-	4,4,4	0.71	0	6,6,6	0.11	0
3	SO4	F	2503	-	4,4,4	0.69	0	6,6,6	0.09	0
4	FAD	H	480	-	58,58,58	1.22	6 (10%)	85,89,89	1.17	10 (11%)
3	SO4	I	2514	-	4,4,4	0.70	0	6,6,6	0.09	0
3	SO4	D	2497	-	4,4,4	0.71	0	6,6,6	0.08	0
4	FAD	B	480	-	58,58,58	1.34	7 (12%)	85,89,89	1.06	7 (8%)
3	SO4	E	2499	-	4,4,4	0.72	0	6,6,6	0.07	0
3	SO4	H	2512	-	4,4,4	0.69	0	6,6,6	0.06	0
3	SO4	A	2484	-	4,4,4	0.69	0	6,6,6	0.06	0
4	FAD	A	480	-	58,58,58	1.35	8 (13%)	85,89,89	1.09	6 (7%)
3	SO4	J	2518	-	4,4,4	0.70	0	6,6,6	0.05	0

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
4	FAD	F	480	-	-	5/34/50/50	0/6/6/6
4	FAD	D	480	-	-	4/34/50/50	0/6/6/6
4	FAD	I	480	-	-	4/34/50/50	0/6/6/6
4	FAD	E	480	-	-	4/34/50/50	0/6/6/6
4	FAD	H	480	-	-	4/34/50/50	0/6/6/6
4	FAD	C	480	-	-	5/34/50/50	0/6/6/6
4	FAD	B	480	-	-	4/34/50/50	0/6/6/6
4	FAD	J	480	-	-	5/34/50/50	0/6/6/6
4	FAD	A	480	-	-	4/34/50/50	0/6/6/6
4	FAD	G	480	-	-	5/34/50/50	0/6/6/6

The worst 5 of 74 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	F	480	FAD	PA-O3P	7.27	1.67	1.59
4	G	480	FAD	C4X-N5	4.76	1.41	1.30
4	B	480	FAD	C4X-N5	4.63	1.40	1.30
4	I	480	FAD	C4X-N5	4.49	1.40	1.30
4	A	480	FAD	C4X-N5	4.38	1.40	1.30

The worst 5 of 66 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	480	FAD	C9A-C5X-N5	-2.92	119.36	122.45
4	H	480	FAD	C9A-C5X-N5	-2.85	119.43	122.45
4	C	480	FAD	C9A-C5X-N5	-2.84	119.44	122.45
4	B	480	FAD	O4B-C1B-C2B	-2.84	100.54	106.62
4	F	480	FAD	C9A-C5X-N5	-2.73	119.56	122.45

There are no chirality outliers.

5 of 44 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	E	480	FAD	O4B-C4B-C5B-O5B
4	C	480	FAD	O4B-C4B-C5B-O5B
4	G	480	FAD	O4B-C4B-C5B-O5B
4	I	480	FAD	O4B-C4B-C5B-O5B

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Mol	Chain	Res	Type	Atoms
4	I	480	FAD	C3B-C4B-C5B-O5B

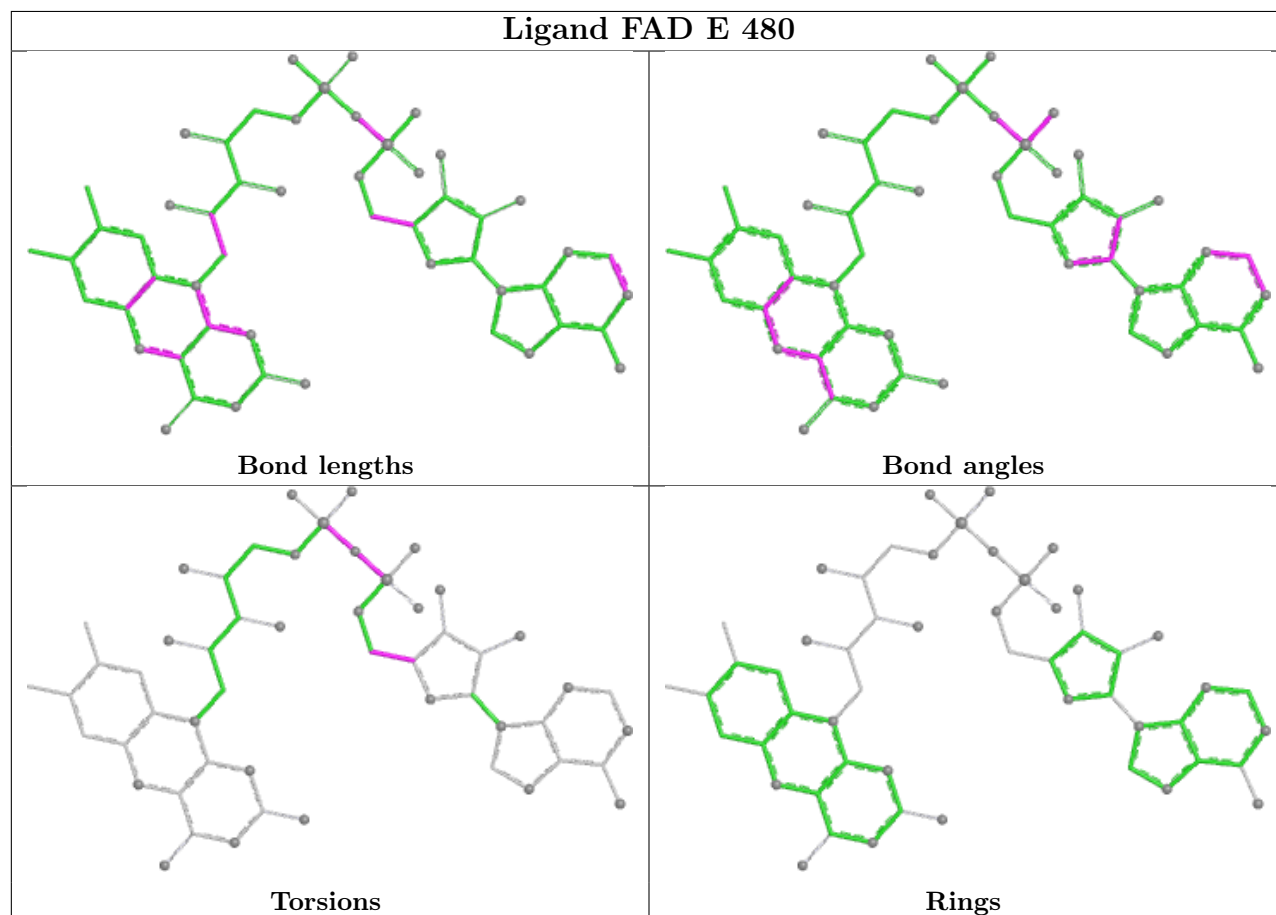
There are no ring outliers.

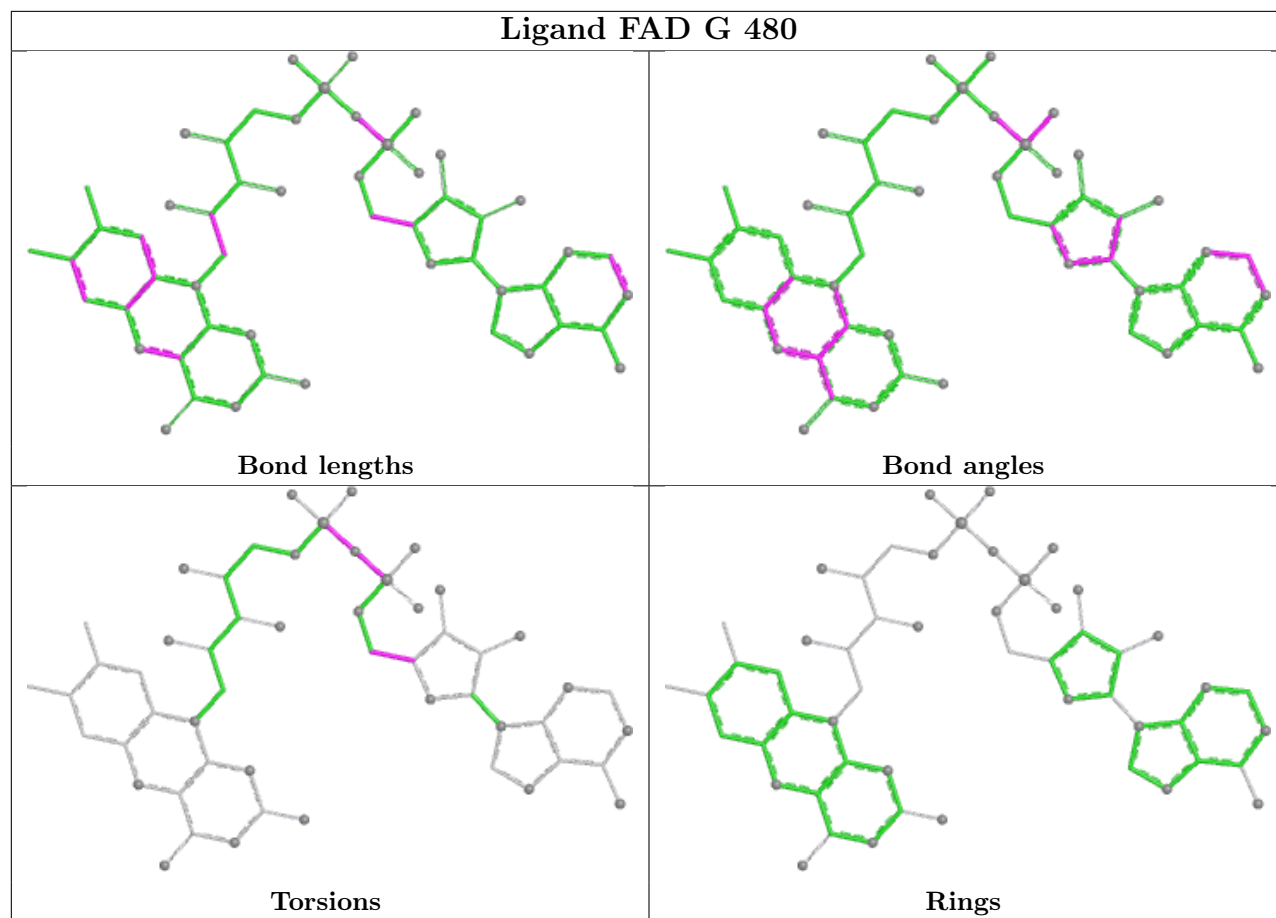
28 monomers are involved in 50 short contacts:

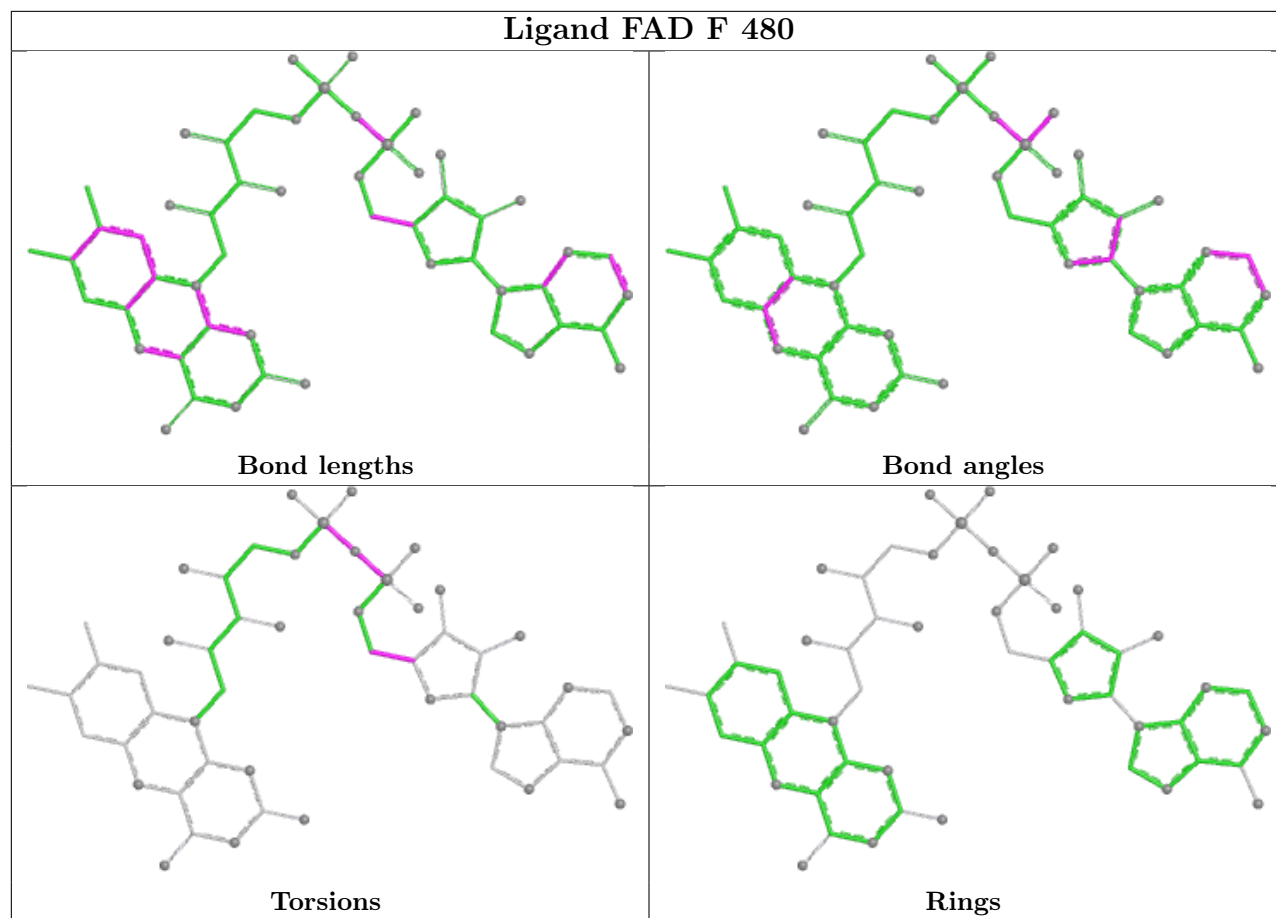
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	2487	SO4	1	0
3	G	2509	SO4	1	0
4	E	480	FAD	2	0
3	J	2520	SO4	2	0
3	H	2511	SO4	2	0
3	J	2519	SO4	1	0
3	I	2515	SO4	2	0
3	B	2489	SO4	2	0
3	F	2505	SO4	1	0
4	G	480	FAD	2	0
4	F	480	FAD	4	0
3	A	2485	SO4	1	0
3	C	2493	SO4	1	0
4	C	480	FAD	3	0
4	J	480	FAD	3	0
4	D	480	FAD	2	0
3	F	2502	SO4	1	0
3	E	2498	SO4	1	0
3	B	2486	SO4	1	0
4	I	480	FAD	1	0
3	I	2516	SO4	1	0
3	H	2510	SO4	2	0
4	H	480	FAD	5	0
4	B	480	FAD	2	0
3	E	2499	SO4	2	0
3	A	2484	SO4	1	0
4	A	480	FAD	2	0
3	J	2518	SO4	1	0

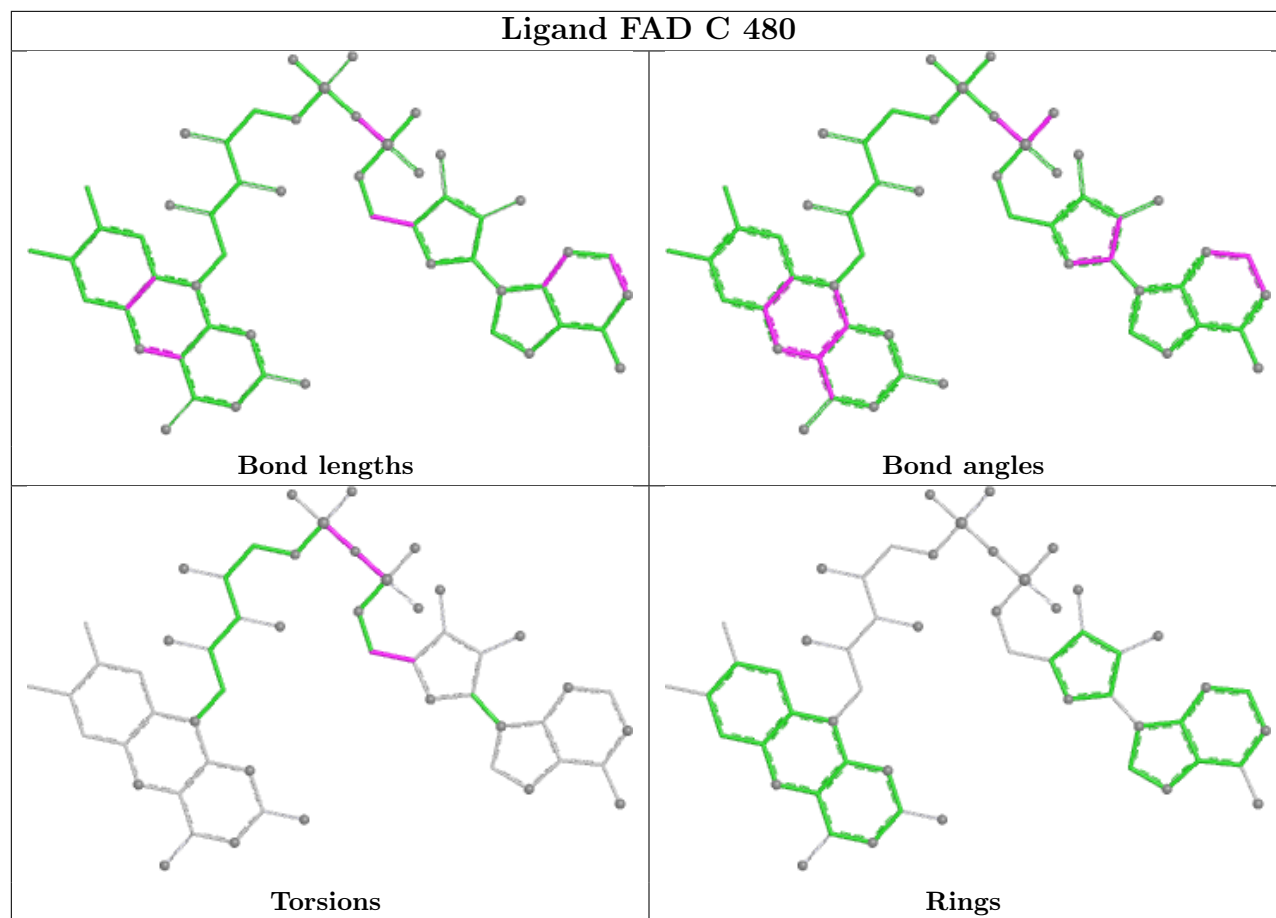
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 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.

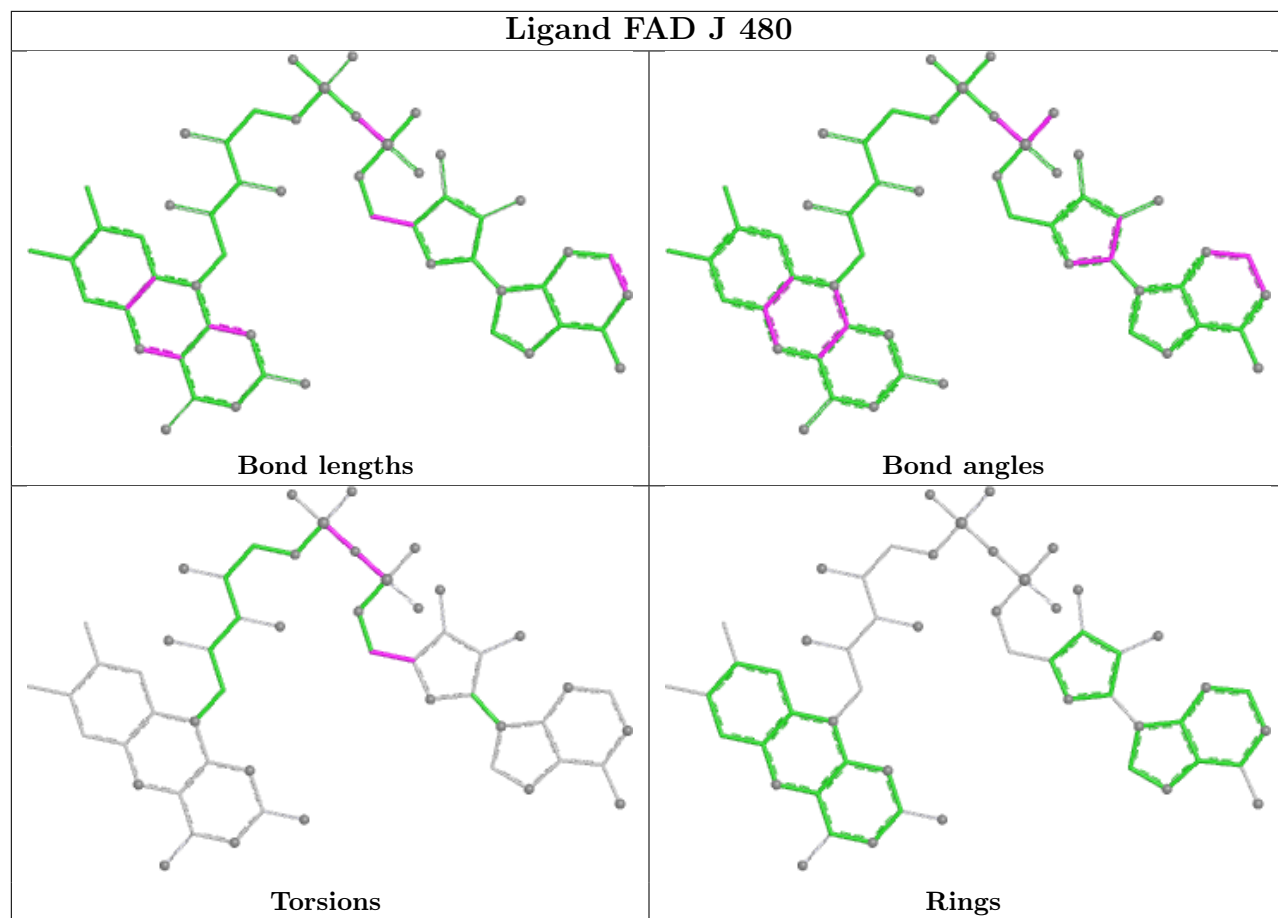


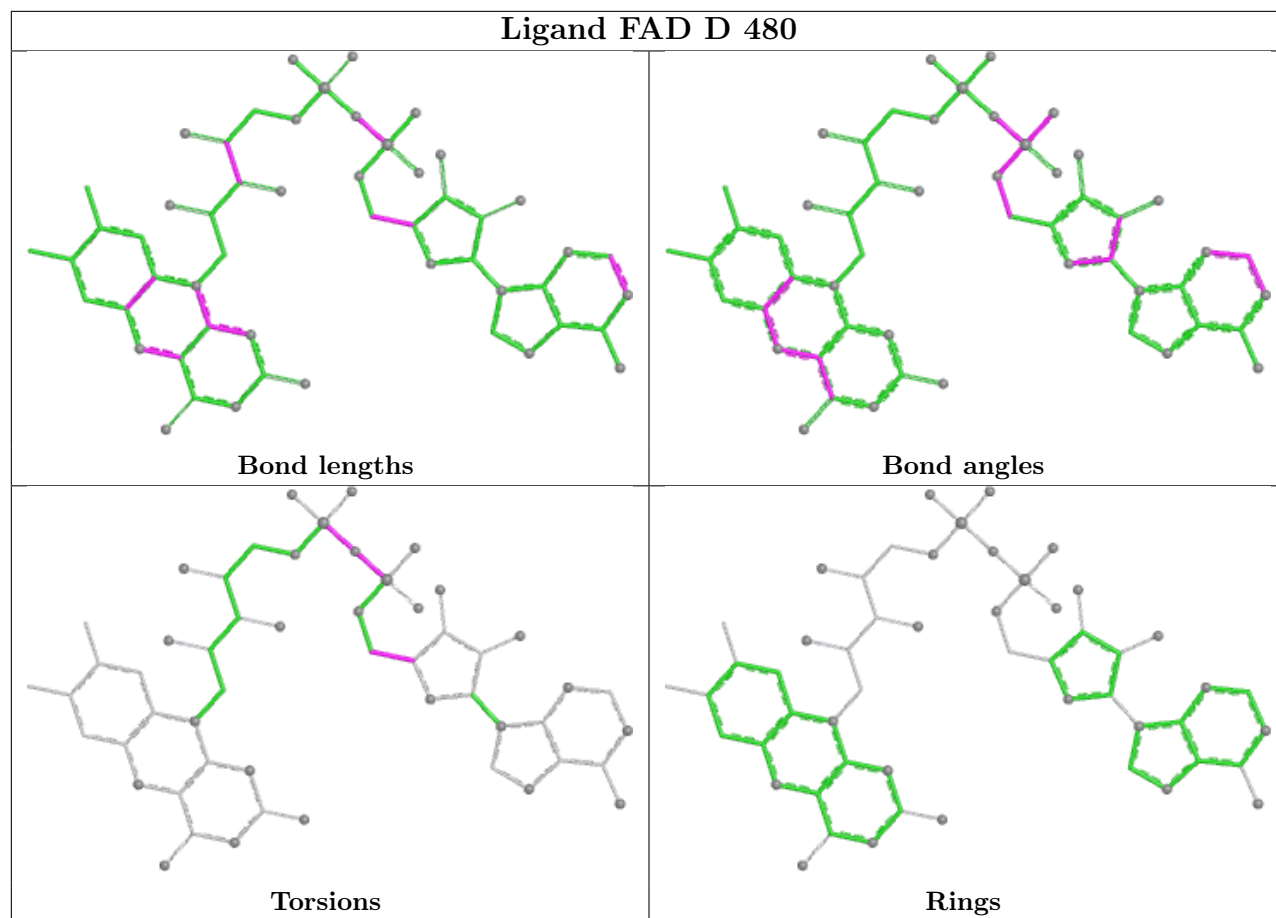




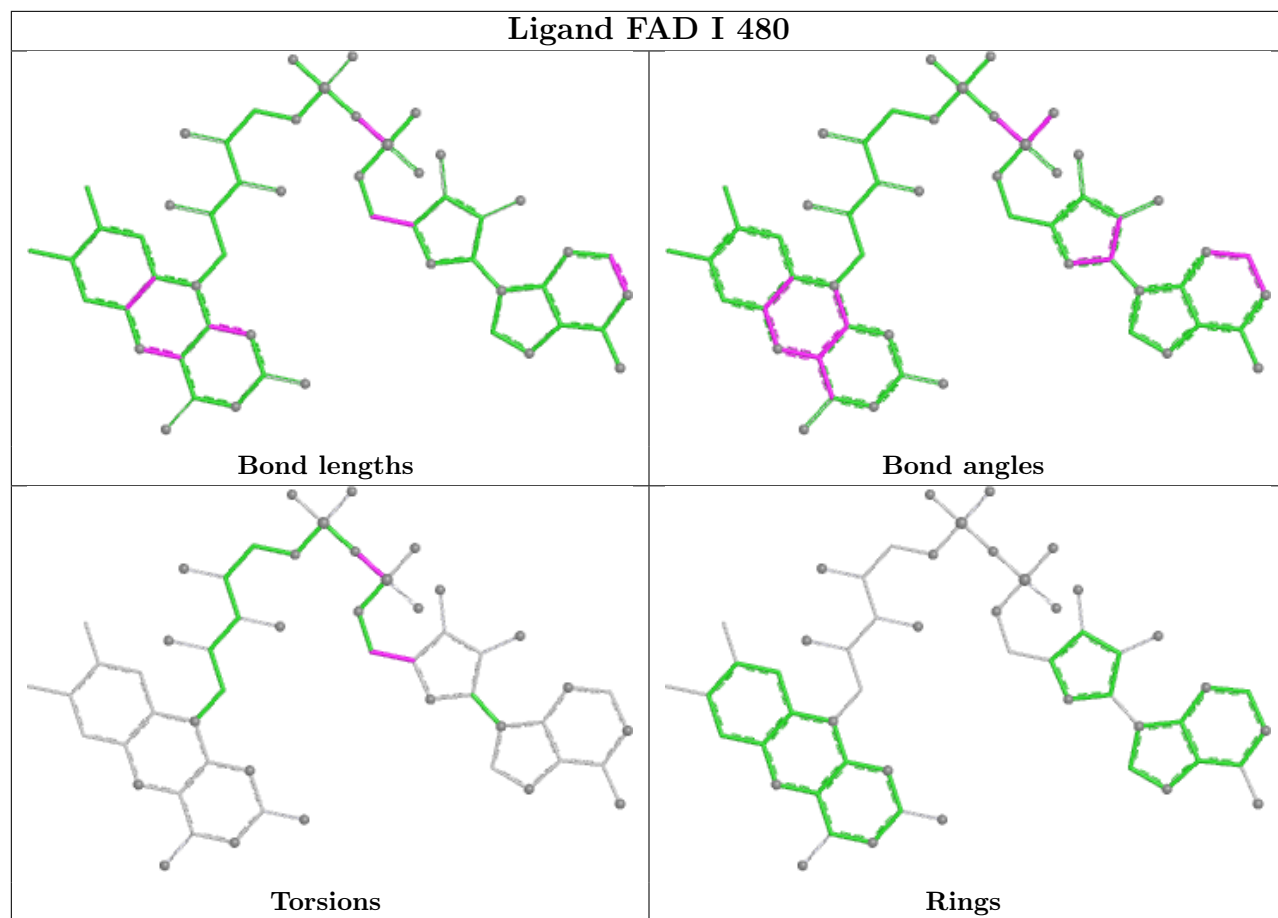


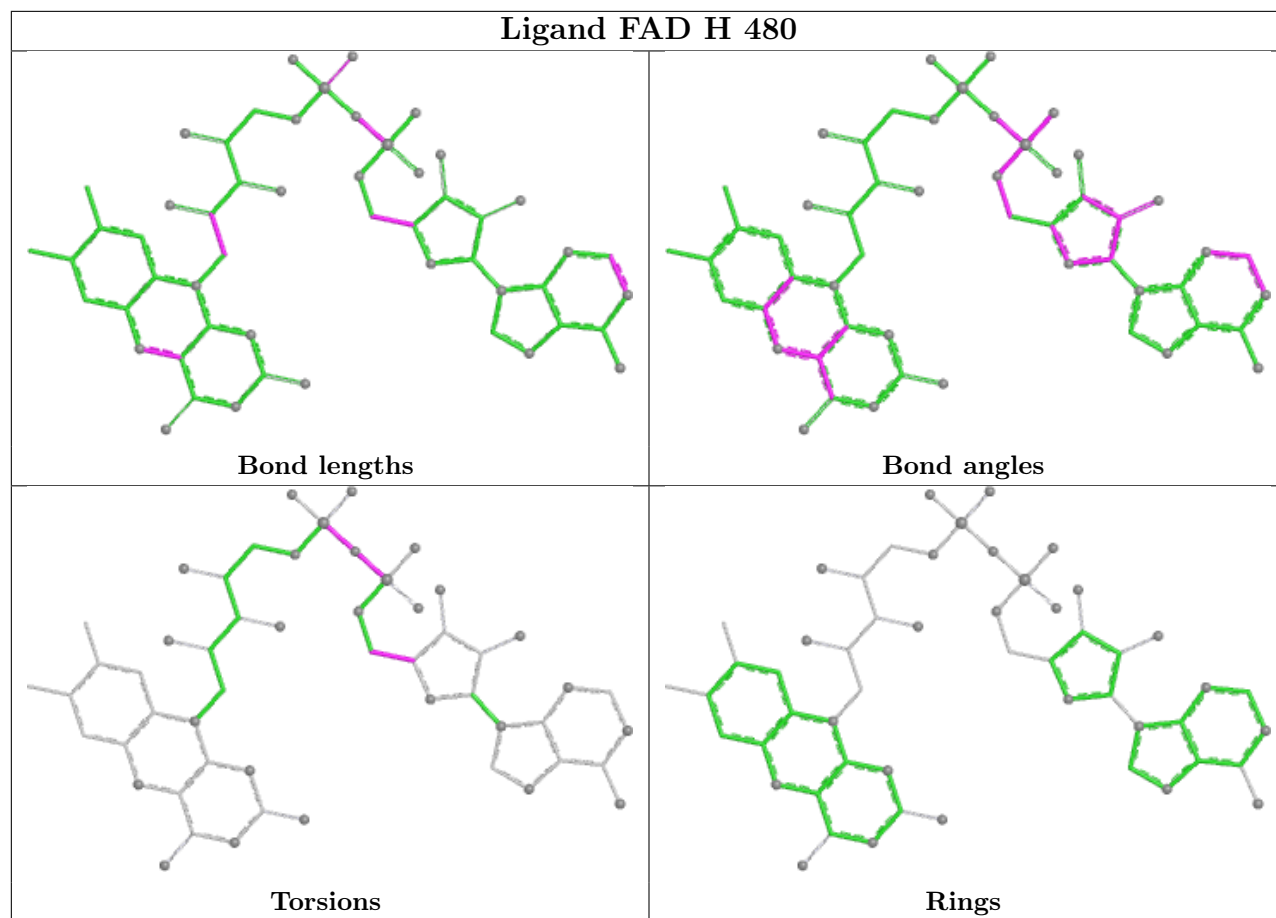
Ligand FAD J 480

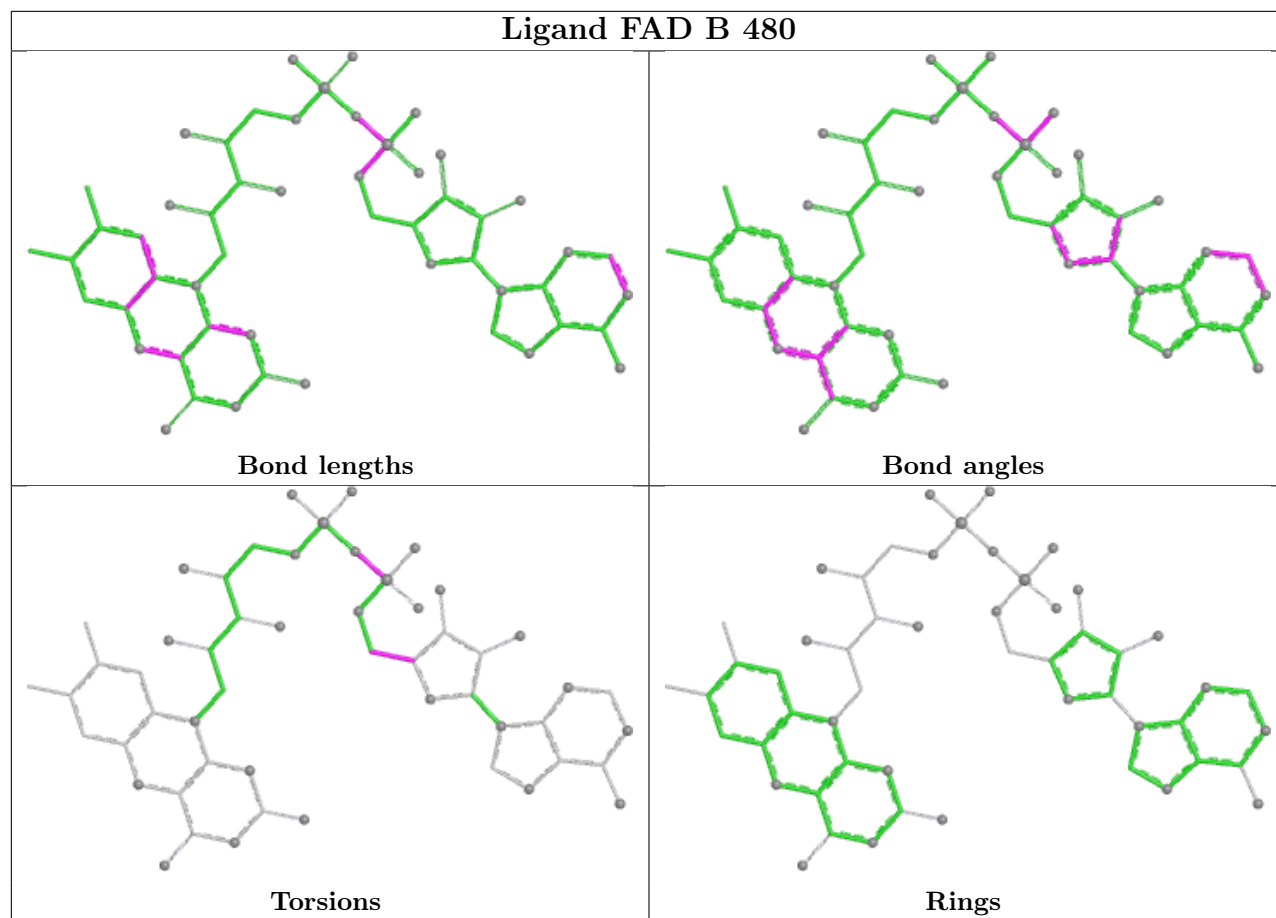


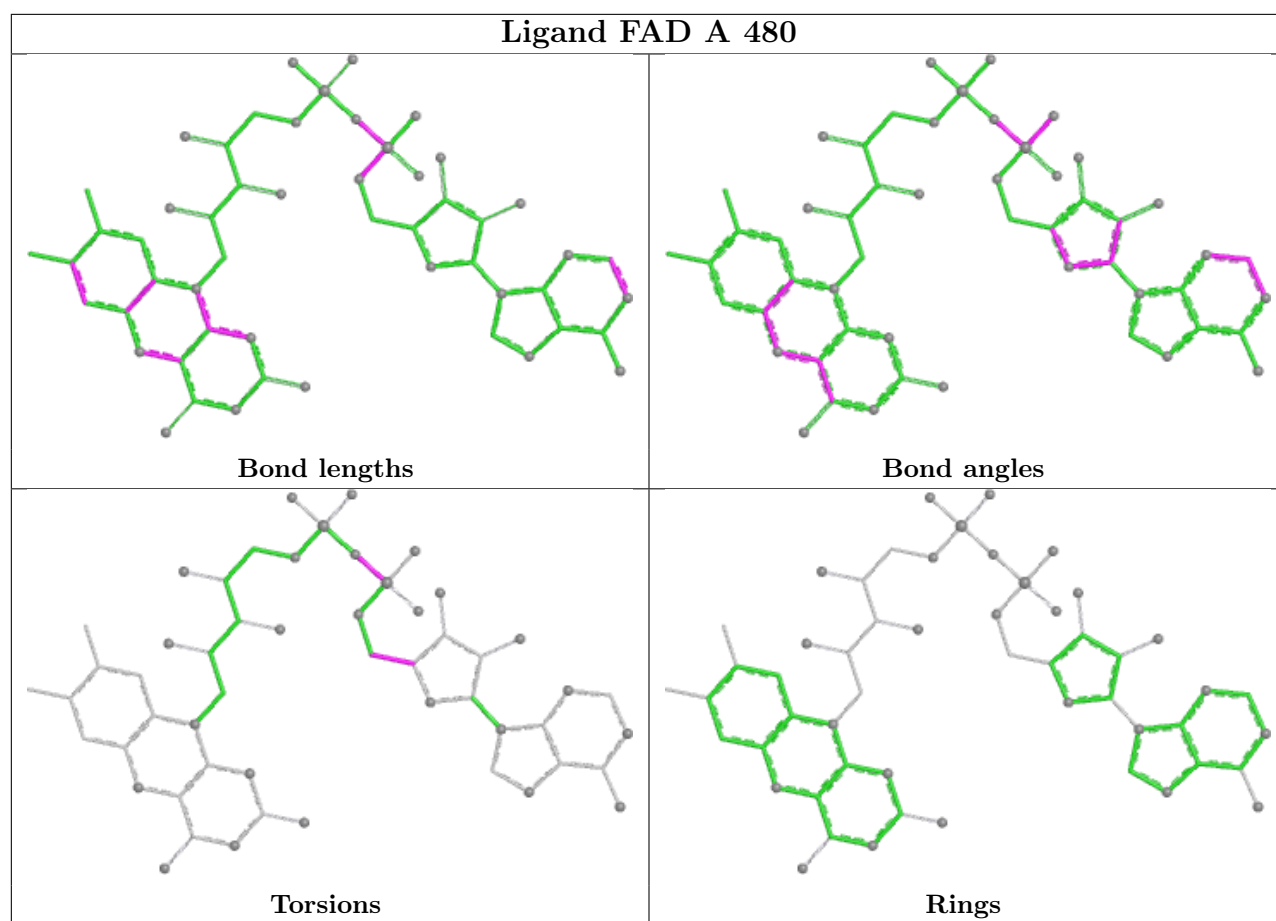


Ligand FAD I 480









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, 95th 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	472/474 (99%)	0.46	23 (4%) 35 34	26, 44, 68, 86	0
1	B	471/474 (99%)	0.95	82 (17%) 4 3	28, 51, 84, 93	0
1	C	472/474 (99%)	0.09	16 (3%) 48 47	23, 36, 61, 79	0
1	D	471/474 (99%)	-0.23	8 (1%) 69 68	21, 31, 53, 74	0
1	E	472/474 (99%)	0.16	15 (3%) 50 49	24, 37, 60, 81	0
1	F	471/474 (99%)	-0.18	5 (1%) 78 77	20, 32, 54, 73	0
1	G	472/474 (99%)	0.02	13 (2%) 55 54	21, 36, 60, 79	0
1	H	472/474 (99%)	-0.44	6 (1%) 75 75	16, 27, 48, 66	0
1	I	470/474 (99%)	0.69	45 (9%) 13 12	27, 49, 76, 86	0
1	J	472/474 (99%)	0.16	11 (2%) 61 60	25, 38, 60, 82	0
2	K	43/64 (67%)	2.01	19 (44%) 0 0	54, 68, 81, 92	0
2	L	43/64 (67%)	3.99	39 (90%) 0 0	18, 24, 29, 30	43 (100%)
2	M	43/64 (67%)	3.95	41 (95%) 0 0	17, 24, 28, 29	43 (100%)
2	N	43/64 (67%)	3.57	36 (83%) 0 0	19, 26, 30, 31	43 (100%)
2	O	43/64 (67%)	4.40	40 (93%) 0 0	18, 25, 29, 30	43 (100%)
All	All	4930/5060 (97%)	0.32	399 (8%) 18 17	16, 37, 69, 93	172 (3%)

The worst 5 of 399 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	O	172[A]	THR	11.3
2	M	172[A]	THR	10.7
2	L	172[A]	THR	10.4
2	L	130[A]	ARG	8.3
2	N	172[A]	THR	7.7

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 oligosaccharides 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, 95th 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($\text{\AA}^2$)	Q<0.9
3	SO4	B	2489	5/5	0.52	0.15	100,101,102,106	0
3	SO4	A	2485	5/5	0.55	0.15	91,93,94,98	0
3	SO4	B	2488	5/5	0.69	0.13	92,93,94,97	0
3	SO4	H	2510	5/5	0.70	0.17	93,93,95,96	0
3	SO4	J	2518	5/5	0.71	0.12	93,95,96,96	0
3	SO4	C	2493	5/5	0.75	0.15	80,81,84,86	0
3	SO4	I	2516	5/5	0.77	0.13	84,86,90,91	0
3	SO4	C	2491	5/5	0.77	0.15	86,89,92,92	0
3	SO4	D	2495	5/5	0.78	0.16	83,86,87,87	0
3	SO4	A	2483	5/5	0.79	0.16	88,92,93,95	0
3	SO4	G	2509	5/5	0.80	0.12	88,88,91,94	0
3	SO4	E	2499	5/5	0.80	0.13	85,87,89,90	0
3	SO4	I	2515	5/5	0.81	0.13	94,94,97,97	0
3	SO4	E	2501	5/5	0.81	0.13	79,81,81,84	0
3	SO4	F	2503	5/5	0.81	0.15	80,81,83,84	0
3	SO4	J	2520	5/5	0.81	0.14	72,73,76,76	0
3	SO4	E	2498	5/5	0.83	0.13	77,81,81,85	0
3	SO4	F	2505	5/5	0.83	0.14	64,65,71,72	0
3	SO4	G	2508	5/5	0.83	0.14	84,85,88,89	0
3	SO4	G	2507	5/5	0.84	0.12	87,87,89,91	0
3	SO4	J	2519	5/5	0.84	0.12	86,86,88,89	0
3	SO4	B	2487	5/5	0.84	0.12	89,91,92,92	0
3	SO4	C	2492	5/5	0.85	0.11	86,88,88,88	0
3	SO4	D	2497	5/5	0.86	0.12	58,62,66,67	0
3	SO4	F	2504	5/5	0.86	0.13	76,76,80,80	0
3	SO4	B	2486	5/5	0.87	0.10	87,90,90,92	0
3	SO4	E	2500	5/5	0.88	0.11	83,83,85,87	0

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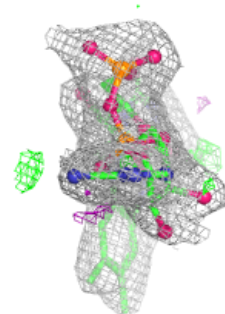
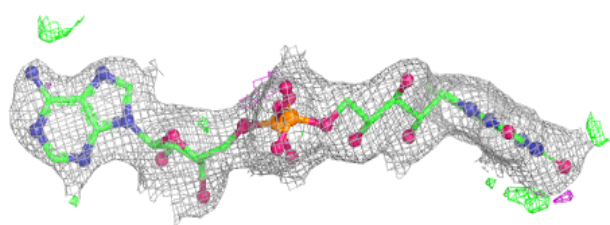
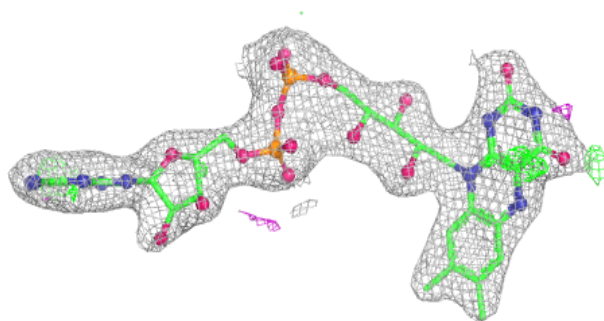
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
3	SO4	A	2482	5/5	0.88	0.12	74,79,83,83	0
3	SO4	A	2484	5/5	0.89	0.11	77,78,79,81	0
3	SO4	C	2490	5/5	0.89	0.13	73,77,81,82	0
3	SO4	G	2506	5/5	0.89	0.10	79,80,81,81	0
3	SO4	J	2517	5/5	0.90	0.12	65,68,69,70	0
3	SO4	D	2496	5/5	0.91	0.10	74,74,76,79	0
3	SO4	H	2511	5/5	0.91	0.13	75,79,83,83	0
3	SO4	H	2513	5/5	0.91	0.12	60,61,67,70	0
3	SO4	F	2502	5/5	0.92	0.12	54,59,65,66	0
3	SO4	I	2514	5/5	0.92	0.12	72,74,78,80	0
3	SO4	H	2512	5/5	0.93	0.14	58,60,64,69	0
4	FAD	B	480	53/53	0.93	0.12	42,55,68,70	0
4	FAD	A	480	53/53	0.95	0.09	28,39,57,58	0
3	SO4	D	2494	5/5	0.95	0.12	61,64,65,68	0
4	FAD	I	480	53/53	0.95	0.09	31,44,56,57	0
4	FAD	E	480	53/53	0.96	0.08	26,35,41,43	0
4	FAD	G	480	53/53	0.96	0.07	21,31,46,51	0
4	FAD	C	480	53/53	0.96	0.08	25,32,39,43	0
4	FAD	J	480	53/53	0.96	0.08	23,30,37,39	0
4	FAD	F	480	53/53	0.97	0.07	21,29,38,39	0
4	FAD	D	480	53/53	0.97	0.06	21,27,32,36	0
4	FAD	H	480	53/53	0.98	0.05	14,21,28,38	0

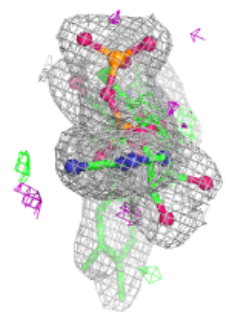
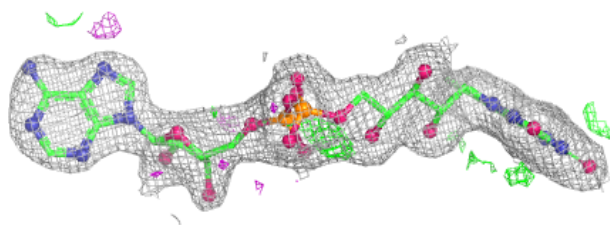
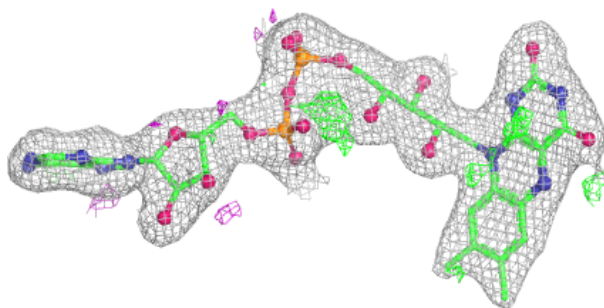
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around FAD B 480:

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

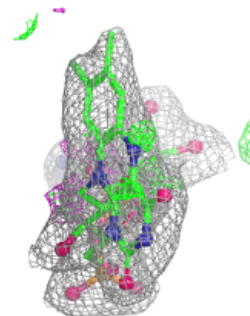
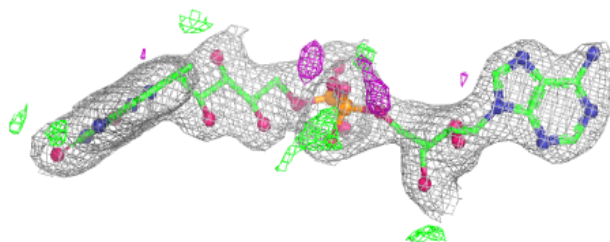
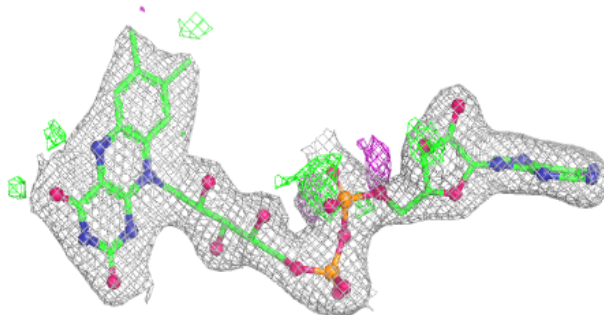
**Electron density around FAD A 480:**

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

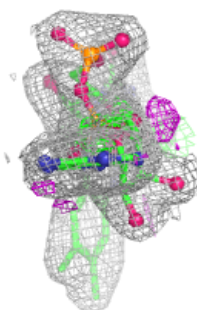
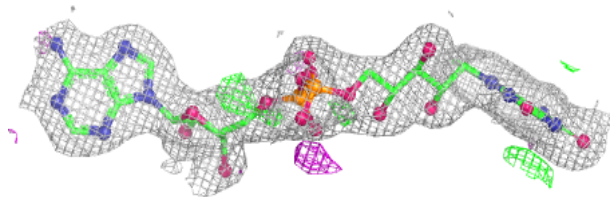
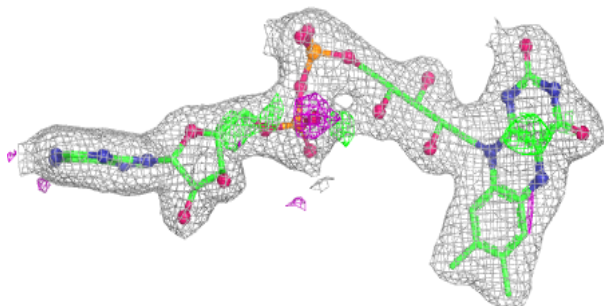


Electron density around FAD I 480:

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

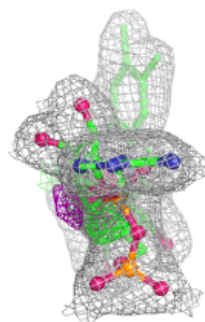
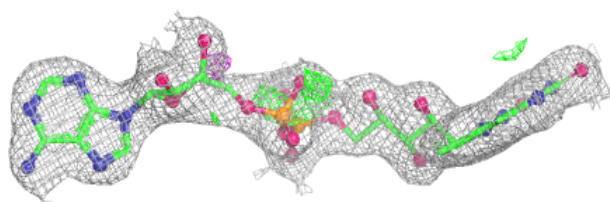
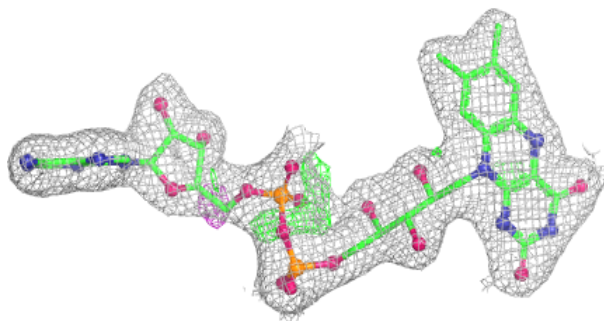
**Electron density around FAD E 480:**

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

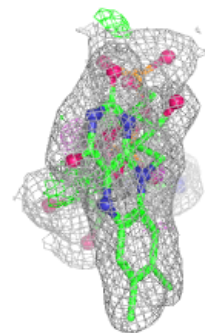
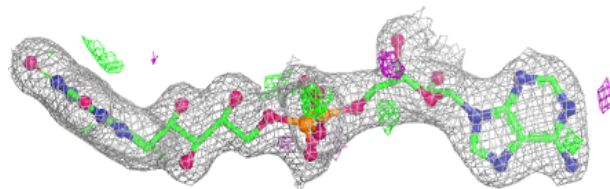
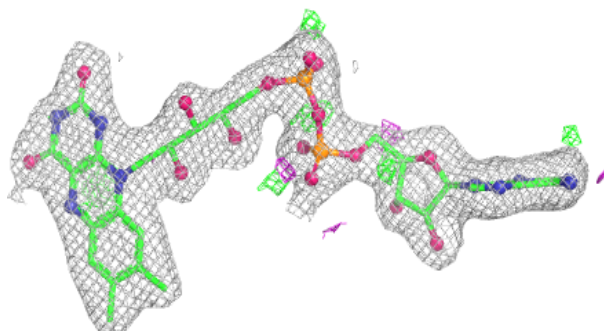


Electron density around FAD G 480:

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

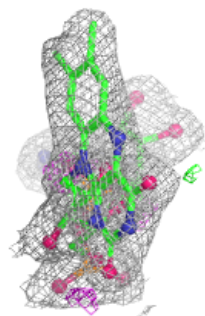
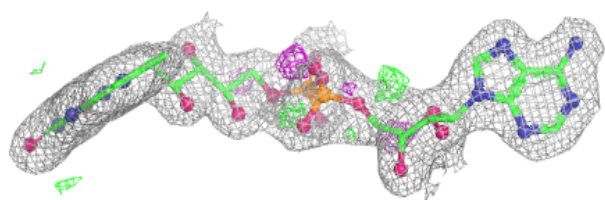
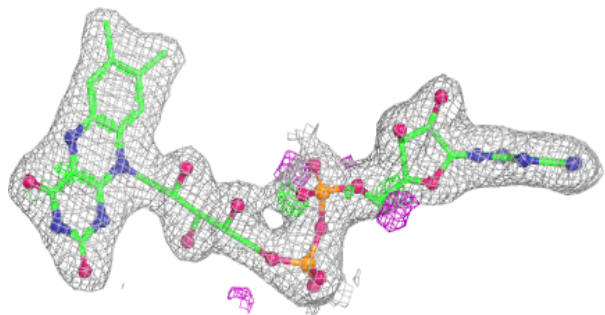
**Electron density around FAD C 480:**

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

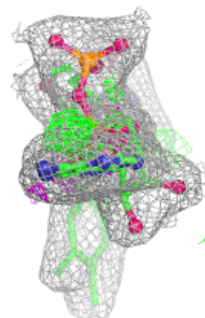
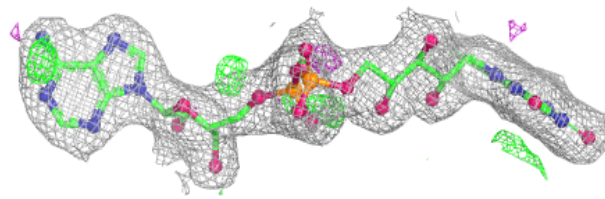
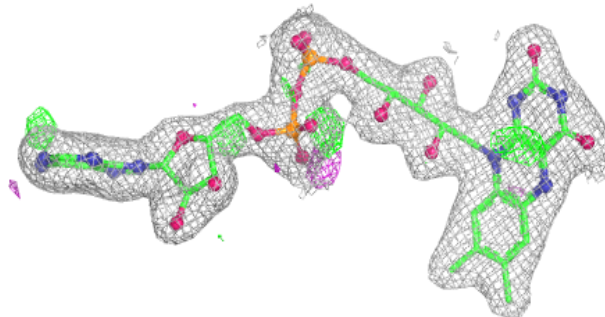


Electron density around FAD J 480:

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

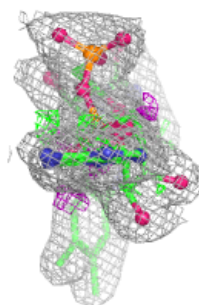
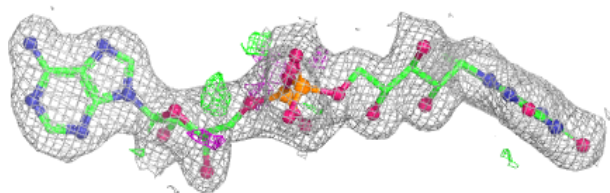
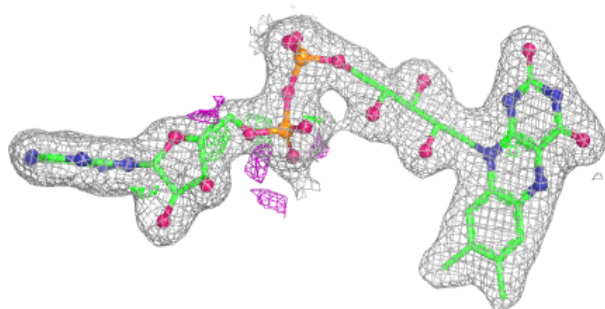
**Electron density around FAD F 480:**

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

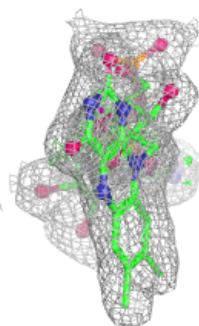
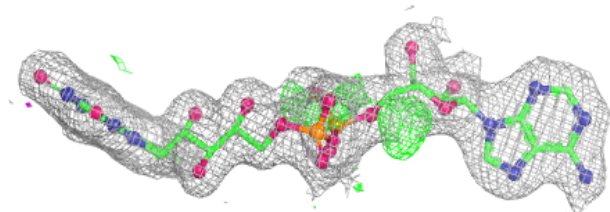
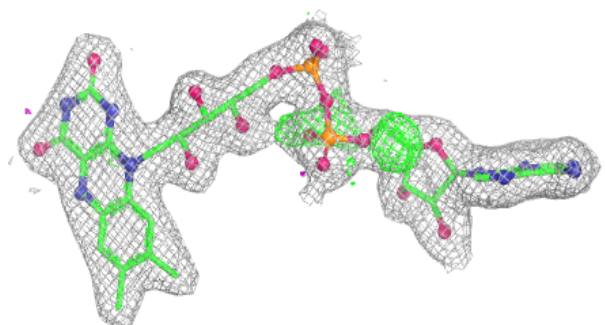


Electron density around FAD D 480:

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

**Electron density around FAD H 480:**

$2mF_o-DF_c$ (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.