



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 05:33 PM UTC

PDB ID : 1ZP4 / pdb\_00001zp4  
Title : Glu28Gln mutant of E. coli Methylenetetrahydrofolate Reductase (oxidized)  
complex with Methyltetrahydrofolate  
Authors : Pejchal, R.; Sargeant, R.; Ludwig, M.L.  
Deposited on : 2005-05-16  
Resolution : 1.85 Å(reported)

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

We welcome your comments at [validation@mail.wwpdb.org](mailto: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>.

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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

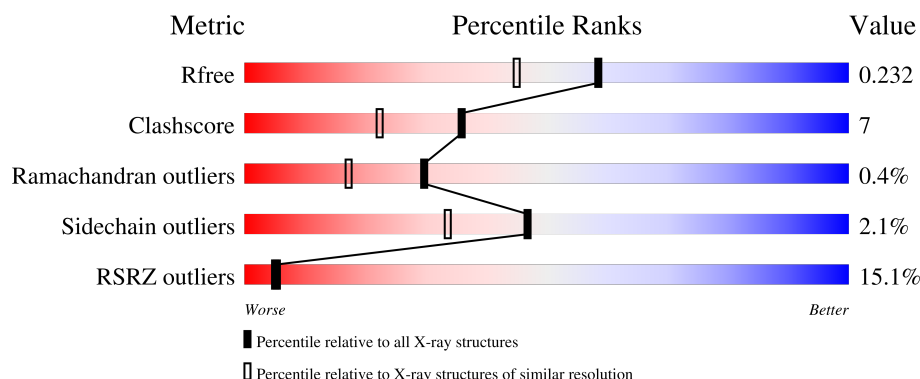
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.85 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	3428 (1.86-1.86)
Clashscore	190562	3579 (1.86-1.86)
Ramachandran outliers	187476	3553 (1.86-1.86)
Sidechain outliers	187428	3553 (1.86-1.86)
RSRZ outliers	180081	3429 (1.86-1.86)

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  $\geq 3$ , 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	304	<div> <div>31%</div> <div>74% 17% • 7%</div> </div>
1	B	304	<div> <div>6%</div> <div>81% 12% • 6%</div> </div>
1	C	304	<div> <div>4%</div> <div>76% 11% • 12%</div> </div>

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 7230 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 5,10-methylenetetrahydrofolate reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	282	Total	C	N	O	S	0	0	0
			2153	1369	372	401	11			
1	B	285	Total	C	N	O	S	0	0	0
			2225	1405	392	417	11			
1	C	267	Total	C	N	O	S	0	0	0
			2075	1316	361	387	11			

There are 27 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	28	GLN	GLU	engineered mutation	UNP P00394
A	297	LEU	-	cloning artifact	UNP P00394
A	298	GLU	-	cloning artifact	UNP P00394
A	299	HIS	-	expression tag	UNP P00394
A	300	HIS	-	expression tag	UNP P00394
A	301	HIS	-	expression tag	UNP P00394
A	302	HIS	-	expression tag	UNP P00394
A	303	HIS	-	expression tag	UNP P00394
A	304	HIS	-	expression tag	UNP P00394
B	28	GLN	GLU	engineered mutation	UNP P00394
B	297	LEU	-	cloning artifact	UNP P00394
B	298	GLU	-	cloning artifact	UNP P00394
B	299	HIS	-	expression tag	UNP P00394
B	300	HIS	-	expression tag	UNP P00394
B	301	HIS	-	expression tag	UNP P00394
B	302	HIS	-	expression tag	UNP P00394
B	303	HIS	-	expression tag	UNP P00394
B	304	HIS	-	expression tag	UNP P00394
C	28	GLN	GLU	engineered mutation	UNP P00394
C	297	LEU	-	cloning artifact	UNP P00394
C	298	GLU	-	cloning artifact	UNP P00394
C	299	HIS	-	expression tag	UNP P00394
C	300	HIS	-	expression tag	UNP P00394

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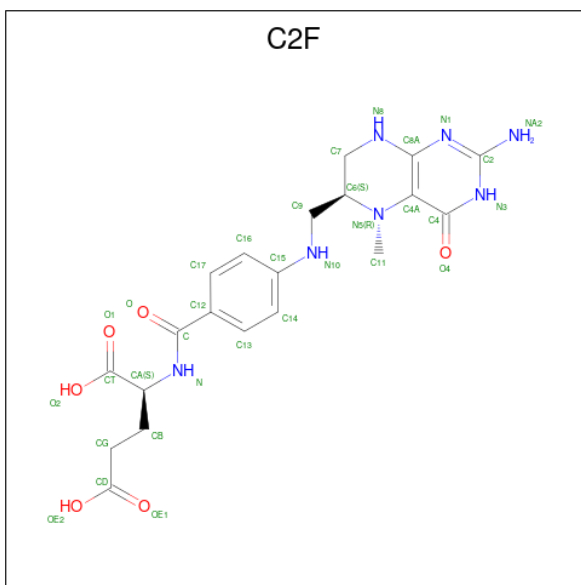
Chain	Residue	Modelled	Actual	Comment	Reference
C	301	HIS	-	expression tag	UNP P00394
C	302	HIS	-	expression tag	UNP P00394
C	303	HIS	-	expression tag	UNP P00394
C	304	HIS	-	expression tag	UNP P00394

- Molecule 2 is SULFATE ION (CCD ID: SO4) (formula: O<sub>4</sub>S).



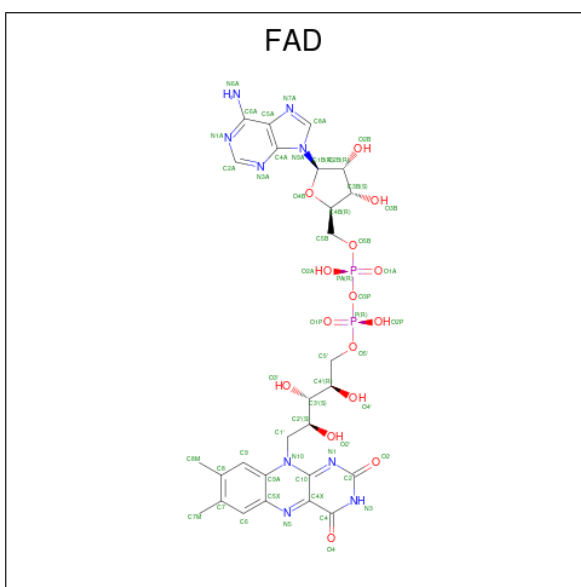
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	O	S	0	0
			5	4	1		
2	C	1	Total	O	S	0	0
			5	4	1		

- Molecule 3 is 5-METHYL-5,6,7,8-TETRAHYDROFOLIC ACID (CCD ID: C2F) (formula: C<sub>20</sub>H<sub>25</sub>N<sub>7</sub>O<sub>6</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total 33	C 20	N 7	O 6	0	0
3	B	1	Total 33	C 20	N 7	O 6	0	0
3	C	1	Total 33	C 20	N 7	O 6	0	0

- Molecule 4 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula:  $C_{27}H_{33}N_9O_{15}P_2$ ).



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

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

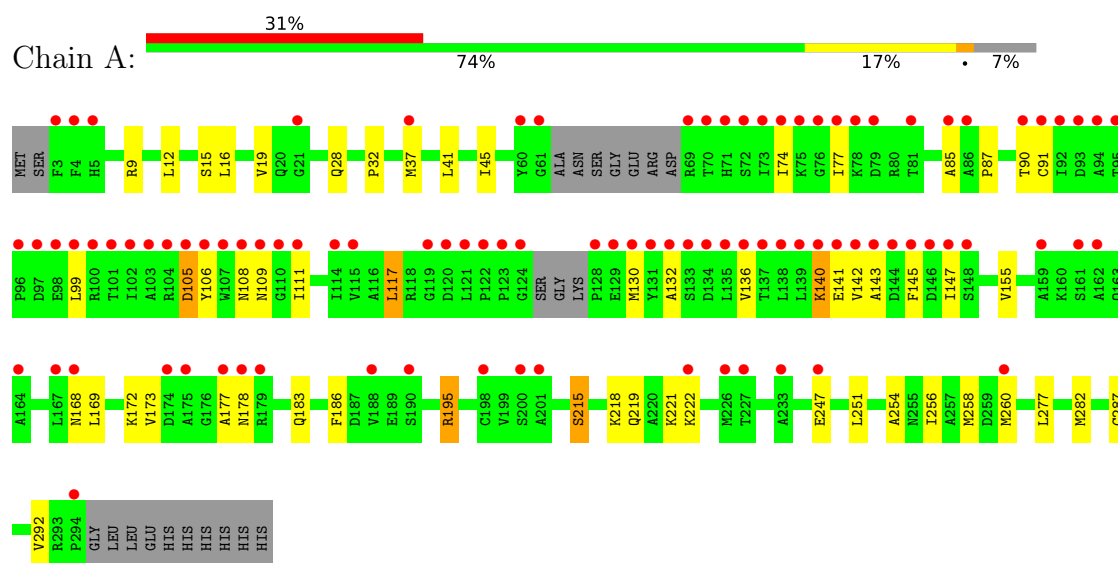
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	87	Total	O	0	0
			87	87		
5	B	203	Total	O	0	0
			203	203		
5	C	219	Total	O	0	0
			219	219		

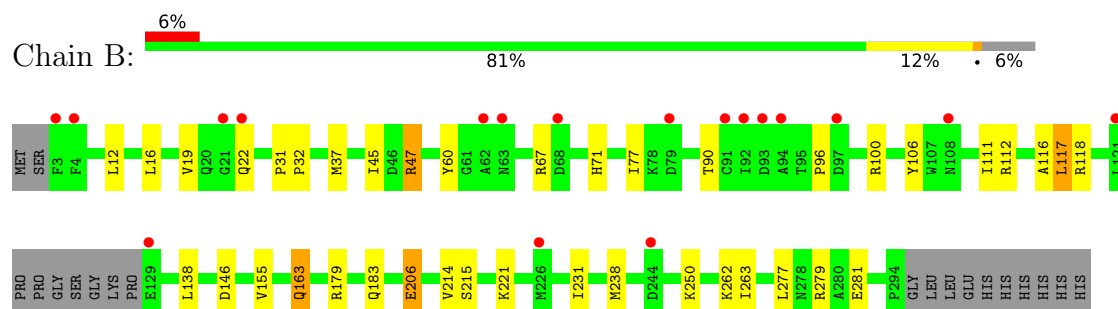
### 3 Residue-property plots [i](#)

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.

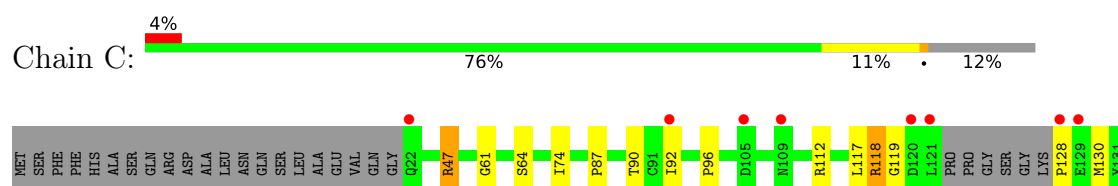
- Molecule 1: 5,10-methylenetetrahydrofolate reductase

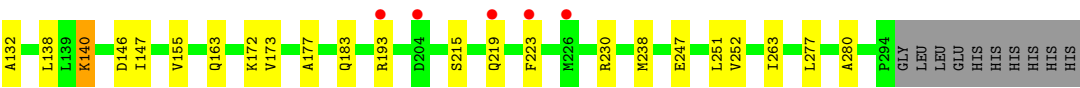


- Molecule 1: 5,10-methylenetetrahydrofolate reductase



- Molecule 1: 5,10-methylenetetrahydrofolate reductase







## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	103.59Å 127.81Å 97.95Å 90.00° 121.88° 90.00°	Depositor
Resolution (Å)	17.27 – 1.85 17.27 – 1.85	Depositor EDS
% Data completeness (in resolution range)	99.5 (17.27-1.85) 99.4 (17.27-1.85)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.06	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.78 (at 1.75Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, $R_{free}$	0.213 , 0.231 0.213 , 0.232	Depositor DCC
$R_{free}$ test set	4572 reflections (4.35%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	23.4	Xtriage
Anisotropy	0.418	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.56 , 73.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.016 for h,-k,-h-l	Xtriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	7230	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.91% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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 [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, C2F, 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	0.34	0/2198	0.81	2/2987 (0.1%)
1	B	0.38	0/2269	0.83	5/3075 (0.2%)
1	C	0.37	0/2118	0.85	5/2873 (0.2%)
All	All	0.37	0/6585	0.83	12/8935 (0.1%)

There are no bond length outliers.

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	183	GLN	N-CA-C	-8.79	98.92	110.53
1	C	146	ASP	N-CA-C	-8.36	95.58	109.46
1	B	146	ASP	N-CA-C	-8.13	95.97	109.46
1	A	183	GLN	N-CA-C	-7.72	99.61	110.50
1	C	183	GLN	N-CA-C	-7.33	100.83	110.43
1	C	215	SER	N-CA-C	-6.16	106.41	114.04
1	B	118	ARG	N-CA-C	-6.12	104.53	111.14
1	A	215	SER	N-CA-C	-5.87	106.16	113.55
1	C	118	ARG	N-CA-C	-5.51	104.91	111.69
1	C	119	GLY	N-CA-C	5.35	118.73	111.72
1	B	214	VAL	N-CA-C	5.24	115.64	107.99
1	B	215	SER	N-CA-C	-5.06	107.05	113.43

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	2153	0	2079	44	0
1	B	2225	0	2170	29	0
1	C	2075	0	2024	29	0
2	A	5	0	0	0	0
2	C	5	0	0	0	0
3	A	33	0	23	4	0
3	B	33	0	23	1	0
3	C	33	0	23	5	0
4	A	53	0	31	0	0
4	B	53	0	31	0	0
4	C	53	0	31	0	0
5	A	87	0	0	1	0
5	B	203	0	0	4	0
5	C	219	0	0	1	1
All	All	7230	0	6435	96	1

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 7.

All (96) 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:B:19:VAL:HG12	1:C:230:ARG:HH22	1.24	1.00
1:A:195:ARG:HH21	1:A:195:ARG:HB3	1.51	0.76
1:A:16:LEU:O	1:A:19:VAL:HG22	1.91	0.71
1:C:277:LEU:HD13	3:C:997:C2F:HG2	1.71	0.71
1:A:143:ALA:HB3	1:A:145:PHE:CE1	2.26	0.70
1:A:9:ARG:HD2	1:C:263:ILE:CD1	2.22	0.70
1:C:112:ARG:HG2	1:C:112:ARG:HH21	1.57	0.70
1:B:12:LEU:HD21	1:B:263:ILE:HD13	1.73	0.69
1:A:186:PHE:HD2	1:A:260:MET:HE1	1.56	0.69
1:B:277:LEU:HD13	3:B:996:C2F:HG2	1.77	0.67
1:A:247:GLU:H	1:A:247:GLU:CD	2.03	0.67
1:C:219:GLN:CB	3:C:997:C2F:HA	2.24	0.67
1:C:219:GLN:HB3	3:C:997:C2F:HA	1.78	0.66
1:A:106:TYR:HB3	1:A:111:ILE:HB	1.77	0.65
1:B:16:LEU:O	1:B:19:VAL:HG22	1.96	0.65
1:A:9:ARG:HD2	1:C:263:ILE:HD12	1.78	0.65
1:B:163:GLN:HE21	1:B:163:GLN:H	1.44	0.64

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:238:MET:HG3	1:C:252:VAL:HG11	1.80	0.61
1:A:91:CYS:SG	1:A:130:MET:HE2	2.39	0.61
1:C:219:GLN:HG3	3:C:997:C2F:O2	2.01	0.60
1:A:105:ASP:O	1:A:109:ASN:OD1	2.19	0.60
1:B:12:LEU:HD21	1:B:263:ILE:CD1	2.30	0.60
1:B:238:MET:HE3	5:B:679:HOH:O	2.02	0.59
1:A:173:VAL:HA	1:A:177:ALA:HB3	1.82	0.59
1:A:111:ILE:HD12	1:A:111:ILE:N	2.18	0.59
1:A:140:LYS:HB3	1:A:140:LYS:NZ	2.17	0.58
1:C:238:MET:HG3	1:C:252:VAL:CG1	2.34	0.57
1:B:163:GLN:H	1:B:163:GLN:NE2	2.02	0.57
1:B:19:VAL:HG12	1:C:230:ARG:NH2	2.07	0.56
1:C:140:LYS:HD3	1:C:147:ILE:HD12	1.88	0.56
1:B:96:PRO:O	1:B:100:ARG:HG3	2.07	0.55
1:C:140:LYS:NZ	1:C:140:LYS:HB3	2.21	0.55
1:C:112:ARG:HG2	1:C:112:ARG:NH2	2.22	0.55
1:A:74:ILE:HG13	1:A:87:PRO:HB3	1.89	0.55
1:C:61:GLY:HA3	1:C:64:SER:OG	2.07	0.55
1:A:221:LYS:HE2	5:A:789:HOH:O	2.07	0.54
1:A:32:PRO:HB3	1:A:37:MET:HG3	1.89	0.54
1:B:67:ARG:HH21	1:B:67:ARG:HG3	1.73	0.54
1:A:277:LEU:HD13	3:A:995:C2F:HG2	1.89	0.53
1:A:28:GLN:HE22	3:A:995:C2F:H111	1.72	0.53
1:A:186:PHE:CD2	1:A:260:MET:HE1	2.40	0.53
1:C:193:ARG:HG3	5:C:739:HOH:O	2.09	0.53
1:A:45:ILE:HD13	1:A:77:ILE:HG12	1.91	0.52
1:C:132:ALA:HB3	1:C:172:LYS:HD3	1.91	0.52
1:C:92:ILE:HD12	1:C:128:PRO:HD3	1.92	0.52
1:B:90:THR:HA	1:B:117:LEU:O	2.11	0.51
1:B:250:LYS:HD3	1:B:281:GLU:OE1	2.10	0.51
1:A:195:ARG:HH21	1:A:195:ARG:CB	2.23	0.51
1:B:138:LEU:C	1:B:138:LEU:HD23	2.35	0.50
1:A:147:ILE:HD12	1:A:147:ILE:N	2.27	0.50
1:A:32:PRO:HD3	1:A:41:LEU:HD22	1.93	0.50
1:A:256:ILE:CG2	1:A:260:MET:HE3	2.41	0.50
1:A:90:THR:HA	1:A:117:LEU:O	2.12	0.50
1:B:238:MET:HG2	5:B:675:HOH:O	2.12	0.50
1:A:256:ILE:O	1:A:260:MET:HG3	2.12	0.49
1:C:138:LEU:C	1:C:138:LEU:HD23	2.37	0.49
1:B:60:TYR:CE2	1:B:67:ARG:HG2	2.47	0.49
1:A:219:GLN:HB3	3:A:995:C2F:HA	1.95	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:223:PHE:CE2	3:C:997:C2F:H92	2.48	0.49
1:A:99:LEU:CD1	1:A:130:MET:HE1	2.44	0.48
1:B:106:TYR:HB3	1:B:111:ILE:HB	1.96	0.47
1:B:179:ARG:HA	5:B:830:HOH:O	2.12	0.47
1:C:90:THR:HA	1:C:117:LEU:O	2.16	0.46
1:C:96:PRO:HG3	1:C:130:MET:CE	2.45	0.46
1:A:105:ASP:OD1	1:A:106:TYR:N	2.48	0.46
1:A:74:ILE:HG23	1:A:85:ALA:HB3	1.97	0.46
1:C:74:ILE:HG13	1:C:87:PRO:HB3	1.98	0.46
1:B:221:LYS:HA	1:B:231:ILE:HD11	1.98	0.46
1:A:28:GLN:NE2	3:A:995:C2F:H111	2.31	0.46
1:B:19:VAL:HA	1:B:22:GLN:NE2	2.30	0.46
1:A:251:LEU:HD23	1:C:251:LEU:HD23	1.98	0.45
1:C:173:VAL:HA	1:C:177:ALA:HB3	1.98	0.45
1:B:279:ARG:HH21	1:B:279:ARG:HG3	1.82	0.45
1:A:254:ALA:O	1:A:258:MET:HG3	2.17	0.45
1:A:132:ALA:O	1:A:136:VAL:HG23	2.17	0.44
1:A:141:GLU:O	1:A:142:VAL:C	2.60	0.44
1:A:215:SER:OG	1:A:282:MET:SD	2.75	0.43
1:C:96:PRO:HG3	1:C:130:MET:HE1	2.01	0.43
1:A:169:LEU:O	1:A:173:VAL:HG23	2.17	0.43
1:B:37:MET:HG2	5:B:801:HOH:O	2.18	0.43
1:A:218:LYS:O	1:A:222:LYS:HG3	2.18	0.43
1:A:108:ASN:C	1:A:109:ASN:OD1	2.62	0.43
1:A:247:GLU:CD	1:A:247:GLU:N	2.76	0.43
1:B:206:GLU:OE1	1:C:163:GLN:HG2	2.18	0.43
1:B:71:HIS:CD2	1:B:106:TYR:OH	2.72	0.42
1:C:47:ARG:HG2	1:C:280:ALA:HB1	2.02	0.42
1:A:168:ASN:O	1:A:172:LYS:HG3	2.20	0.42
1:B:12:LEU:HG	1:B:262:LYS:HG2	2.00	0.42
1:B:31:PRO:HA	1:B:32:PRO:HD3	1.92	0.42
1:B:116:ALA:C	1:B:117:LEU:HG	2.45	0.42
1:A:15:SER:O	1:A:19:VAL:HG13	2.20	0.42
1:A:287:CYS:HB3	1:A:292:VAL:HB	2.02	0.41
1:C:92:ILE:HG12	1:C:118:ARG:O	2.21	0.41
1:A:136:VAL:HG13	1:A:147:ILE:HG21	2.03	0.40
1:B:47:ARG:HH11	1:B:47:ARG:HG3	1.86	0.40
1:B:45:ILE:HD13	1:B:77:ILE:HG12	2.03	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
5:C:707:HOH:O	5:C:707:HOH:O[2_555]	1.27	0.93

## 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	276/304 (91%)	268 (97%)	7 (2%)	1 (0%)	30	17
1	B	281/304 (92%)	279 (99%)	1 (0%)	1 (0%)	30	17
1	C	263/304 (86%)	258 (98%)	4 (2%)	1 (0%)	30	17
All	All	820/912 (90%)	805 (98%)	12 (2%)	3 (0%)	30	17

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	155	VAL
1	B	155	VAL
1	C	155	VAL

### 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	222/258 (86%)	216 (97%)	6 (3%)	39	24
1	B	234/258 (91%)	229 (98%)	5 (2%)	47	33
1	C	218/258 (84%)	215 (99%)	3 (1%)	59	49

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
All	All	674/774 (87%)	660 (98%)	14 (2%)	47 33

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	12	LEU
1	A	105	ASP
1	A	117	LEU
1	A	140	LYS
1	A	178	ASN
1	A	195	ARG
1	B	47	ARG
1	B	112	ARG
1	B	117	LEU
1	B	163	GLN
1	B	206	GLU
1	C	47	ARG
1	C	140	LYS
1	C	247	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	14	GLN
1	A	43	ASN
1	B	14	GLN
1	B	20	GLN
1	B	22	GLN
1	B	28	GLN
1	B	163	GLN
1	C	71	HIS

### 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 [i](#)

There are no oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

8 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$
4	FAD	A	395	-	58,58,58	1.63	12 (20%)	85,89,89	1.40	13 (15%)
3	C2F	B	996	-	32,35,35	1.59	3 (9%)	36,49,49	1.66	6 (16%)
2	SO4	C	999	-	4,4,4	0.36	0	6,6,6	0.09	0
2	SO4	A	998	-	4,4,4	0.35	0	6,6,6	0.05	0
3	C2F	A	995	-	32,35,35	1.58	3 (9%)	36,49,49	1.64	6 (16%)
4	FAD	C	397	-	58,58,58	1.55	9 (15%)	85,89,89	1.17	10 (11%)
4	FAD	B	396	-	58,58,58	1.53	7 (12%)	85,89,89	1.25	11 (12%)
3	C2F	C	997	-	32,35,35	1.58	3 (9%)	36,49,49	1.65	6 (16%)

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	A	395	-	-	2/34/50/50	0/6/6/6
3	C2F	B	996	-	-	2/22/35/35	0/3/3/3
3	C2F	A	995	-	-	2/22/35/35	0/3/3/3
4	FAD	C	397	-	-	4/34/50/50	0/6/6/6
4	FAD	B	396	-	-	3/34/50/50	0/6/6/6
3	C2F	C	997	-	-	2/22/35/35	0/3/3/3

All (37) bond length outliers are listed below:



Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	996	C2F	O4-C4	6.81	1.36	1.23
3	A	995	C2F	O4-C4	6.78	1.36	1.23
3	C	997	C2F	O4-C4	6.75	1.36	1.23
4	C	397	FAD	C10-N10	5.02	1.48	1.37
4	A	395	FAD	C10-N10	4.79	1.47	1.37
4	A	395	FAD	C4X-N5	4.63	1.40	1.30
4	B	396	FAD	C4X-N5	4.57	1.40	1.30
4	C	397	FAD	C4X-N5	4.57	1.40	1.30
4	A	395	FAD	C9A-N10	4.55	1.49	1.41
4	B	396	FAD	C10-N10	4.42	1.46	1.37
4	C	397	FAD	C9-C9A	3.88	1.45	1.39
4	B	396	FAD	C9-C9A	3.87	1.45	1.39
4	A	395	FAD	C9-C9A	3.66	1.45	1.39
4	B	396	FAD	C9A-N10	3.59	1.47	1.41
4	B	396	FAD	C6-C5X	3.28	1.45	1.40
4	C	397	FAD	C6-C5X	3.12	1.44	1.40
4	A	395	FAD	C6-C5X	3.04	1.44	1.40
4	A	395	FAD	C8-C7	2.90	1.47	1.40
4	B	396	FAD	C8-C7	2.88	1.47	1.40
4	C	397	FAD	C8M-C8	2.79	1.56	1.51
4	C	397	FAD	C9A-N10	2.61	1.45	1.41
4	A	395	FAD	P-O3P	2.45	1.62	1.59
4	B	396	FAD	C8M-C8	2.43	1.55	1.51
3	A	995	C2F	C4-N3	-2.33	1.34	1.38
4	A	395	FAD	C5'-C4'	2.32	1.55	1.51
3	B	996	C2F	C4-N3	-2.31	1.34	1.38
3	C	997	C2F	C4-N3	-2.29	1.34	1.38
4	C	397	FAD	C8-C7	2.25	1.46	1.40
4	A	395	FAD	C1'-C2'	2.23	1.55	1.52
4	A	395	FAD	PA-O3P	2.20	1.61	1.59
4	A	395	FAD	C10-N1	2.13	1.37	1.33
4	C	397	FAD	C1'-C2'	-2.12	1.49	1.52
4	A	395	FAD	C9A-C5X	2.07	1.44	1.41
3	A	995	C2F	C7-N8	2.04	1.48	1.46
4	C	397	FAD	C9A-C5X	2.04	1.44	1.41
3	C	997	C2F	C7-N8	2.03	1.48	1.46
3	B	996	C2F	C7-N8	2.03	1.48	1.46

All (52) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	996	C2F	C4A-C4-N3	5.36	120.37	110.94
3	C	997	C2F	C4A-C4-N3	5.32	120.30	110.94

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	995	C2F	C4A-C4-N3	5.28	120.23	110.94
3	B	996	C2F	C2-N1-C8A	4.48	121.26	113.36
3	C	997	C2F	C2-N1-C8A	4.44	121.20	113.36
3	A	995	C2F	C2-N1-C8A	4.42	121.16	113.36
4	A	395	FAD	C5X-C9A-N10	-3.92	114.43	117.97
4	C	397	FAD	C5X-C9A-N10	-3.63	114.69	117.97
4	A	395	FAD	C9A-C5X-N5	3.60	126.27	122.45
4	A	395	FAD	C4'-C3'-C2'	3.57	119.52	113.57
4	B	396	FAD	O2-C2-N3	3.56	125.42	118.58
4	A	395	FAD	C9-C9A-N10	3.41	126.44	121.85
4	B	396	FAD	C5X-C9A-N10	-3.09	115.17	117.97
3	C	997	C2F	O4-C4-C4A	-3.08	120.06	127.62
3	A	995	C2F	O4-C4-C4A	-3.06	120.12	127.62
4	C	397	FAD	C9-C9A-N10	3.00	125.89	121.85
3	B	996	C2F	C11-N5-C6	-2.99	109.04	117.97
3	B	996	C2F	O4-C4-C4A	-2.98	120.30	127.62
3	C	997	C2F	C11-N5-C6	-2.91	109.28	117.97
3	A	995	C2F	C11-N5-C6	-2.91	109.30	117.97
4	C	397	FAD	O5'-C5'-C4'	2.69	116.53	109.36
3	C	997	C2F	C11-N5-C4A	-2.67	109.75	120.28
4	B	396	FAD	C9-C9A-N10	2.65	125.42	121.85
4	B	396	FAD	O5'-C5'-C4'	2.63	116.38	109.36
3	A	995	C2F	C11-N5-C4A	-2.62	109.94	120.28
4	C	397	FAD	O2-C2-N3	2.61	123.59	118.58
3	B	996	C2F	C11-N5-C4A	-2.60	110.02	120.28
4	A	395	FAD	C8M-C8-C7	2.56	125.99	120.76
4	A	395	FAD	O2B-C2B-C1B	2.51	118.74	110.10
4	B	396	FAD	N3-C2-N1	-2.49	114.22	119.50
4	B	396	FAD	C9A-C5X-N5	2.48	125.09	122.45
4	A	395	FAD	C8M-C8-C9	-2.43	115.30	119.57
4	A	395	FAD	O5'-C5'-C4'	2.28	115.44	109.36
4	B	396	FAD	O2B-C2B-C1B	2.25	117.83	110.10
4	C	397	FAD	C10-N1-C2	2.24	121.70	116.85
4	B	396	FAD	C8M-C8-C9	-2.23	115.64	119.57
4	C	397	FAD	C5'-C4'-C3'	2.21	116.38	112.22
3	B	996	C2F	C2-N3-C4	-2.20	121.13	125.11
3	C	997	C2F	C2-N3-C4	-2.19	121.13	125.11
4	B	396	FAD	C8M-C8-C7	2.18	125.21	120.76
3	A	995	C2F	C2-N3-C4	-2.17	121.18	125.11
4	C	397	FAD	O2B-C2B-C1B	2.15	117.50	110.10
4	C	397	FAD	N3-C2-N1	-2.12	114.99	119.50
4	A	395	FAD	O2-C2-N3	2.11	122.63	118.58

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	397	FAD	C9A-C5X-N5	2.11	124.69	122.45
4	B	396	FAD	C10-N1-C2	2.11	121.41	116.85
4	B	396	FAD	O2'-C2'-C3'	2.10	114.17	109.25
4	A	395	FAD	O2P-P-O1P	2.10	122.20	112.44
4	A	395	FAD	O2'-C2'-C3'	2.05	114.04	109.25
4	A	395	FAD	C6-C5X-N5	-2.04	115.06	118.44
4	C	397	FAD	O5B-C5B-C4B	2.03	115.91	108.99
4	A	395	FAD	C7M-C7-C6	-2.00	116.05	119.57

There are no chirality outliers.

All (15) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	C	397	FAD	O2'-C2'-C3'-C4'
4	C	397	FAD	P-O3P-PA-O1A
4	B	396	FAD	O2'-C2'-C3'-C4'
4	A	395	FAD	O2'-C2'-C3'-C4'
4	B	396	FAD	P-O3P-PA-O1A
4	C	397	FAD	P-O3P-PA-O2A
3	B	996	C2F	OE1-CD-CG-CB
3	A	995	C2F	OE2-CD-CG-CB
3	A	995	C2F	OE1-CD-CG-CB
3	B	996	C2F	OE2-CD-CG-CB
4	C	397	FAD	O2'-C2'-C3'-O3'
3	C	997	C2F	OE1-CD-CG-CB
3	C	997	C2F	OE2-CD-CG-CB
4	B	396	FAD	P-O3P-PA-O2A
4	A	395	FAD	PA-O3P-P-O1P

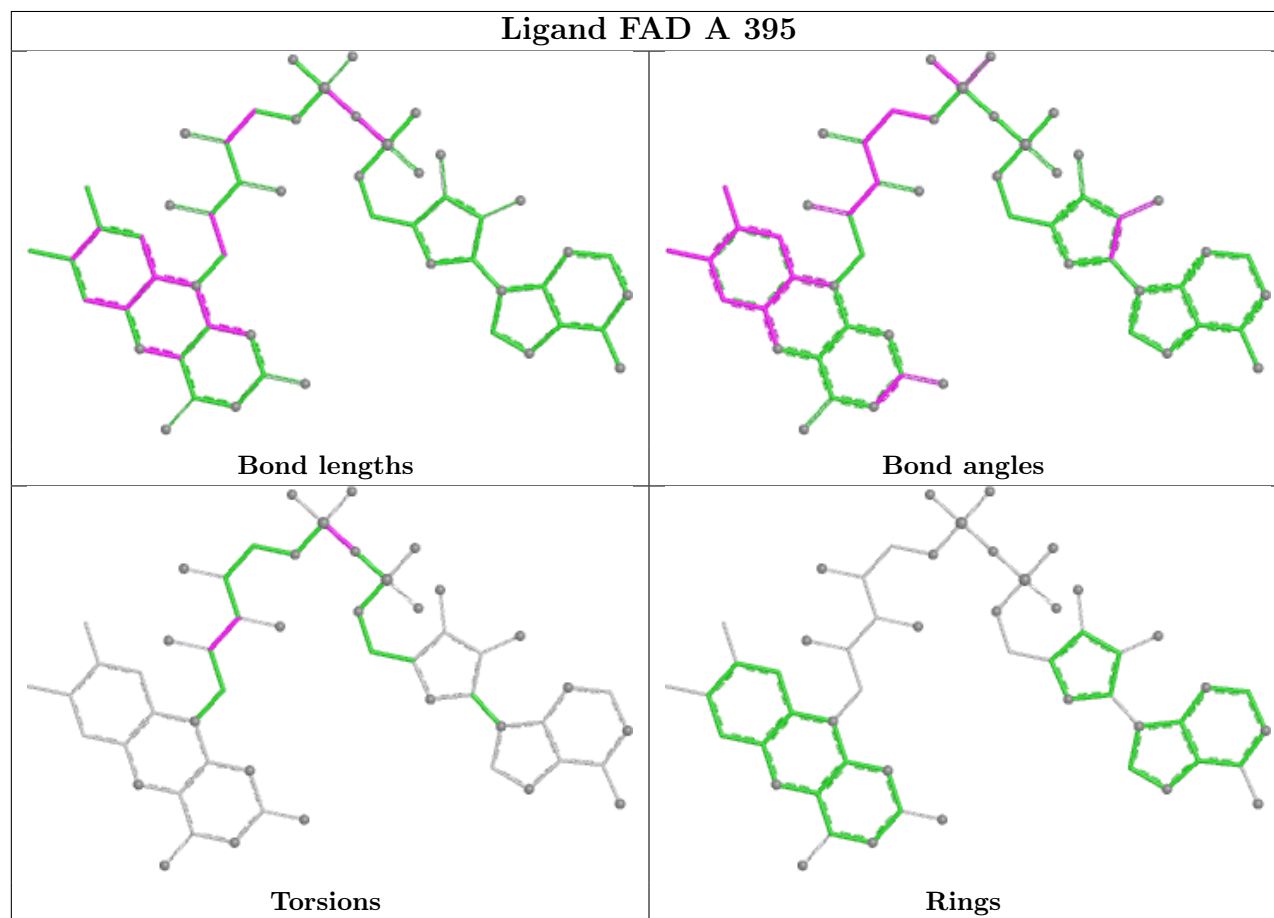
There are no ring outliers.

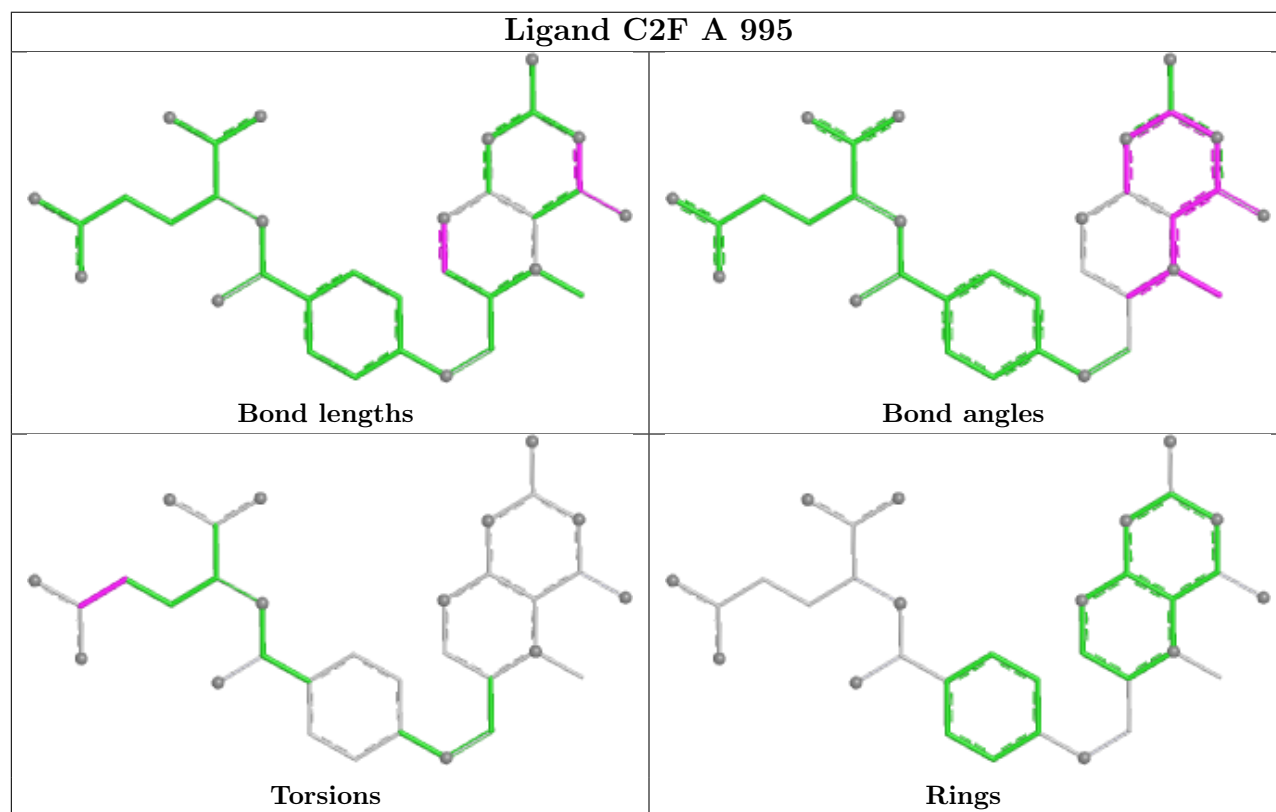
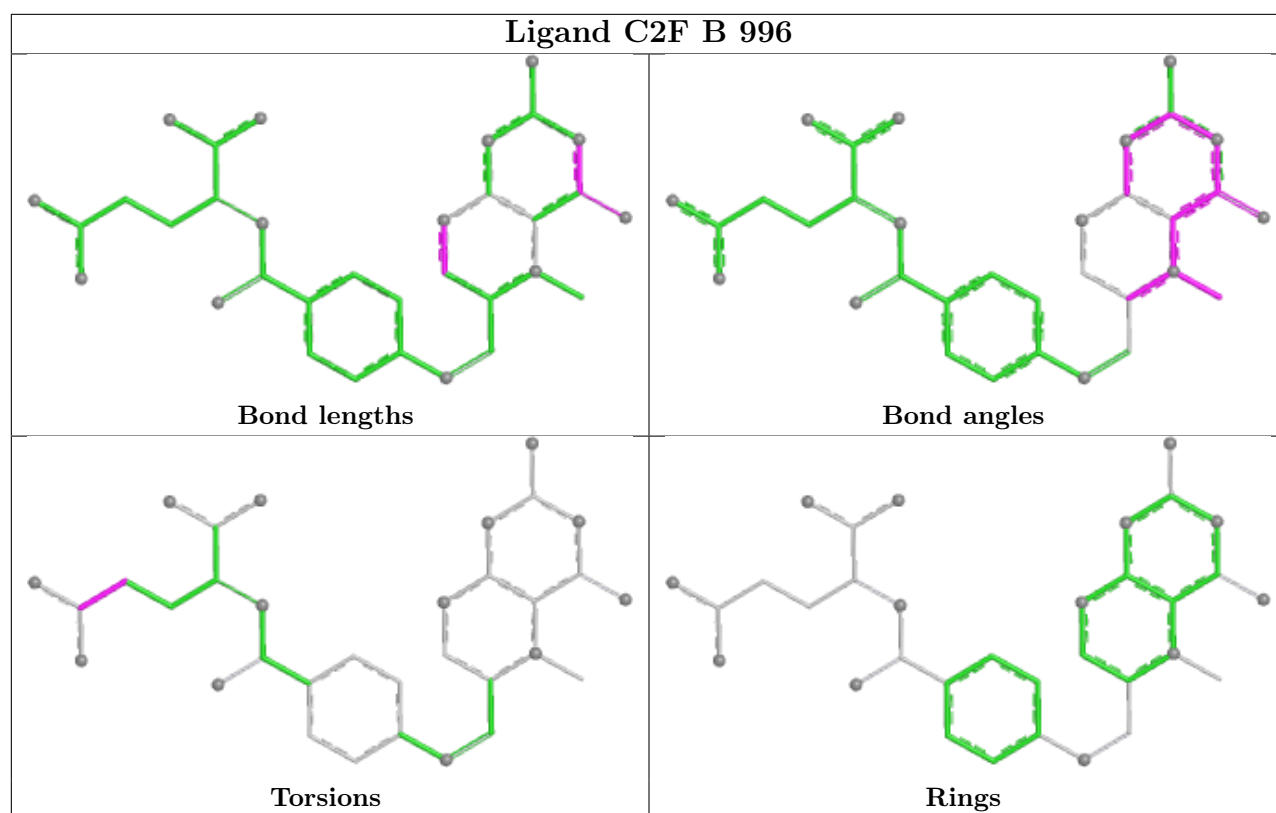
3 monomers are involved in 10 short contacts:

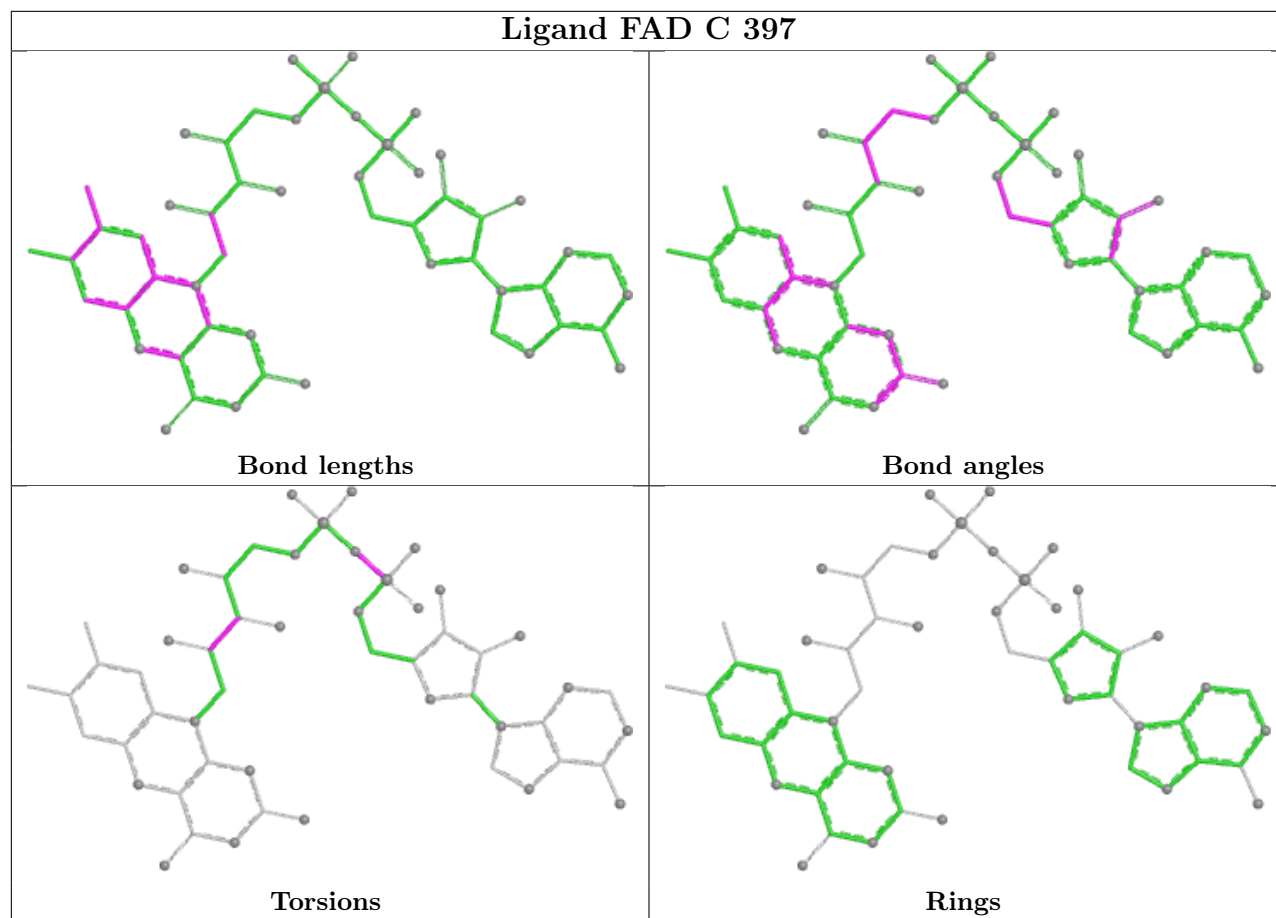
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	996	C2F	1	0
3	A	995	C2F	4	0
3	C	997	C2F	5	0

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.

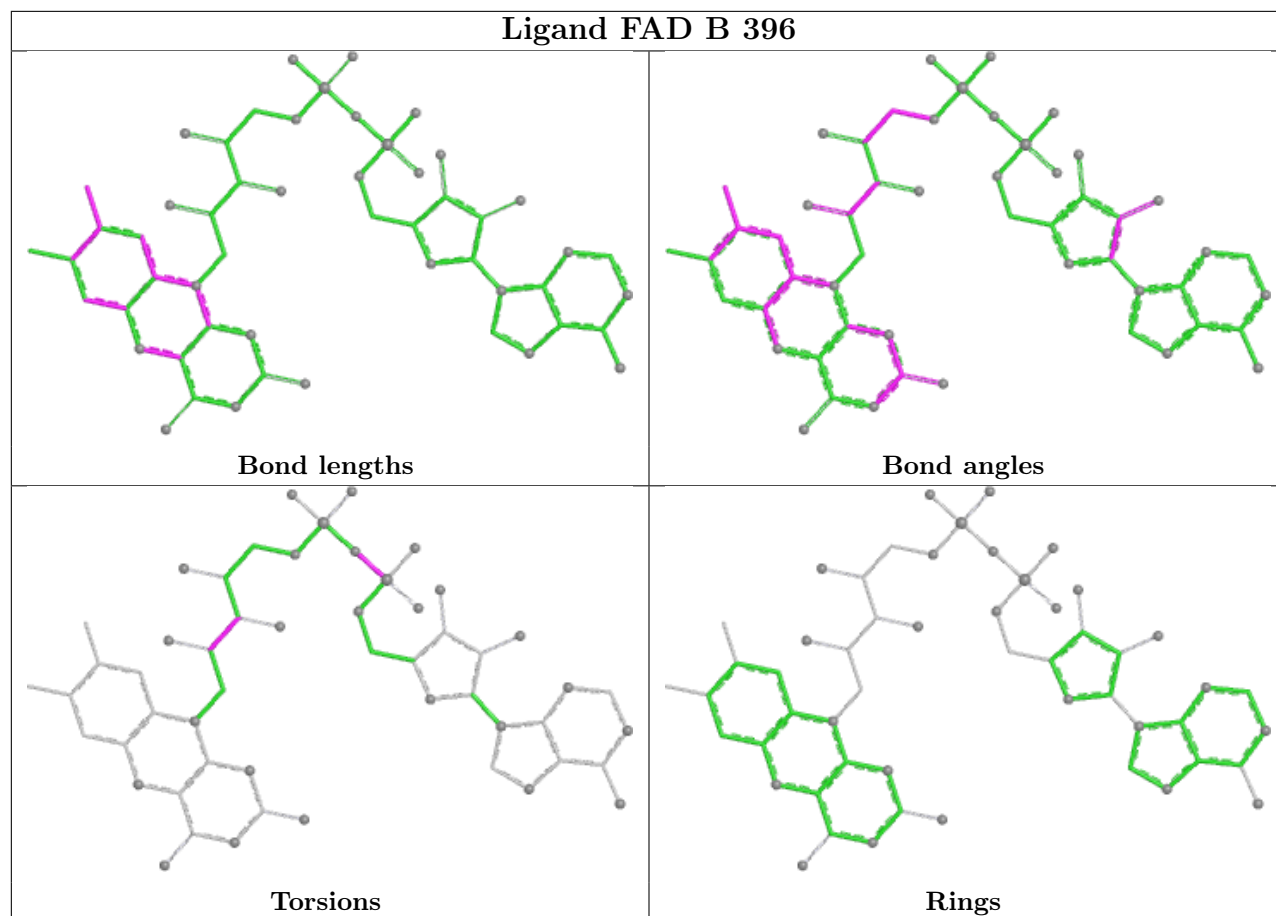
Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD 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.



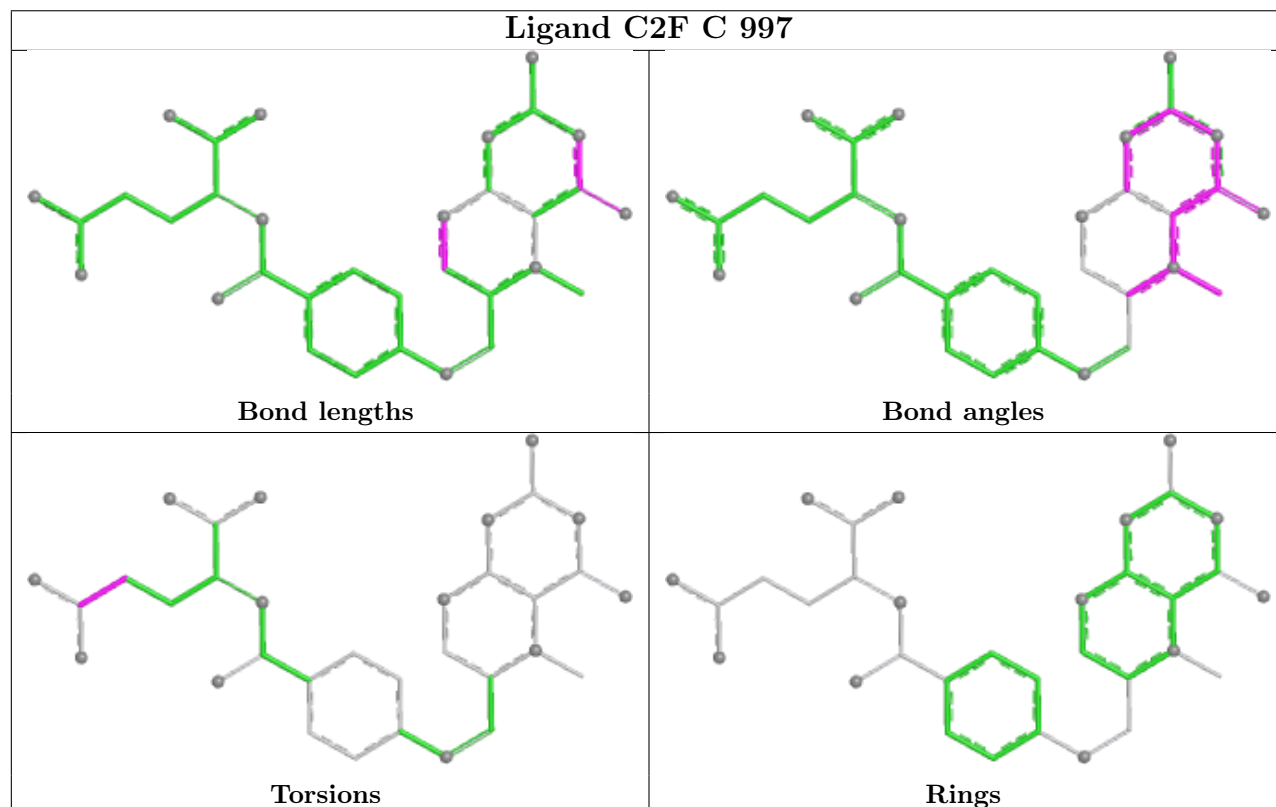




## Ligand FAD B 396



## Ligand C2F C 997



## 5.7 Other polymers

There are no such residues in this entry.

## 5.8 Polymer linkage issues

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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	282/304 (92%)	1.66	95 (33%) 1 1	18, 36, 63, 69	0
1	B	285/304 (93%)	0.29	18 (6%) 26 28	12, 22, 38, 54	0
1	C	267/304 (87%)	0.06	13 (4%) 35 38	12, 20, 32, 47	0
All	All	834/912 (91%)	0.68	126 (15%) 5 5	12, 25, 55, 69	0

All (126) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	105	ASP	9.9
1	A	140	LYS	7.8
1	A	102	ILE	7.3
1	A	97	ASP	7.2
1	A	107	TRP	6.1
1	A	138	LEU	5.7
1	A	106	TYR	5.3
1	A	131	TYR	5.0
1	A	96	PRO	5.0
1	A	124	GLY	4.8
1	A	103	ALA	4.7
1	A	101	THR	4.6
1	A	141	GLU	4.5
1	A	145	PHE	4.3
1	A	79	ASP	4.2
1	A	146	ASP	4.2
1	A	175	ALA	4.2
1	A	143	ALA	4.2
1	C	128	PRO	4.0
1	A	128	PRO	4.0
1	A	178	ASN	4.0
1	A	148	SER	4.0
1	A	104	ARG	3.9

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Mol	Chain	Res	Type	RSRZ
1	A	5	HIS	3.9
1	A	139	LEU	3.9
1	A	137	THR	3.9
1	A	142	VAL	3.9
1	A	92	ILE	3.9
1	A	111	ILE	3.9
1	A	3	PHE	3.9
1	A	135	LEU	3.8
1	A	129	GLU	3.8
1	C	92	ILE	3.8
1	A	60	TYR	3.7
1	A	132	ALA	3.7
1	A	70	THR	3.7
1	A	91	CYS	3.6
1	A	109	ASN	3.5
1	B	62	ALA	3.5
1	C	22	GLN	3.5
1	A	159	ALA	3.5
1	A	130	MET	3.5
1	A	95	THR	3.5
1	A	134	ASP	3.3
1	A	86	ALA	3.3
1	A	121	LEU	3.3
1	A	144	ASP	3.3
1	A	133	SER	3.3
1	A	147	ILE	3.3
1	B	3	PHE	3.2
1	A	136	VAL	3.2
1	A	100	ARG	3.2
1	A	99	LEU	3.1
1	A	123	PRO	3.1
1	B	121	LEU	3.1
1	A	72	SER	3.1
1	A	201	ALA	3.1
1	A	98	GLU	3.0
1	B	94	ALA	3.0
1	A	168	ASN	3.0
1	A	78	LYS	3.0
1	A	190	SER	2.9
1	B	68	ASP	2.9
1	A	69	ARG	2.9
1	A	174	ASP	2.9

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Mol	Chain	Res	Type	RSRZ
1	A	76	GLY	2.9
1	B	21	GLY	2.9
1	A	226	MET	2.9
1	A	167	LEU	2.9
1	A	81	THR	2.8
1	A	94	ALA	2.8
1	A	37	MET	2.8
1	A	233	ALA	2.8
1	A	74	ILE	2.7
1	A	122	PRO	2.7
1	A	75	LYS	2.7
1	A	61	GLY	2.7
1	A	119	GLY	2.7
1	C	223	PHE	2.7
1	C	121	LEU	2.7
1	A	110	GLY	2.6
1	A	77	ILE	2.6
1	B	92	ILE	2.6
1	C	226	MET	2.6
1	C	129	GLU	2.6
1	C	120	ASP	2.6
1	A	115	VAL	2.6
1	C	109	ASN	2.6
1	A	108	ASN	2.5
1	B	22	GLN	2.5
1	A	294	PRO	2.5
1	A	247	GLU	2.5
1	A	120	ASP	2.5
1	A	188	VAL	2.5
1	A	179	ARG	2.4
1	A	114	ILE	2.4
1	C	204	ASP	2.4
1	A	71	HIS	2.4
1	B	97	ASP	2.4
1	A	164	ALA	2.4
1	B	129	GLU	2.4
1	A	200	SER	2.4
1	A	21	GLY	2.3
1	A	162	ALA	2.3
1	A	93	ASP	2.3
1	B	79	ASP	2.3
1	A	227	THR	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	161	SER	2.2
1	A	260	MET	2.2
1	B	226	MET	2.2
1	B	108	ASN	2.2
1	B	93	ASP	2.2
1	B	91	CYS	2.2
1	B	4	PHE	2.1
1	A	73	ILE	2.1
1	A	177	ALA	2.1
1	A	4	PHE	2.1
1	A	222	LYS	2.1
1	B	63	ASN	2.1
1	A	90	THR	2.1
1	A	198	CYS	2.1
1	B	244	ASP	2.1
1	C	105	ASP	2.1
1	C	219	GLN	2.0
1	A	85	ALA	2.0
1	C	193	ARG	2.0

## 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, 95<sup>th</sup> 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	C2F	C	997	33/33	0.74	0.19	33,46,63,64	0
3	C2F	A	995	33/33	0.87	0.12	27,32,50,53	0
4	FAD	A	395	53/53	0.89	0.13	27,30,49,50	0
3	C2F	B	996	33/33	0.90	0.11	18,24,47,49	0

*Continued on next page...*

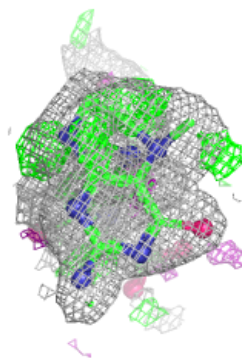
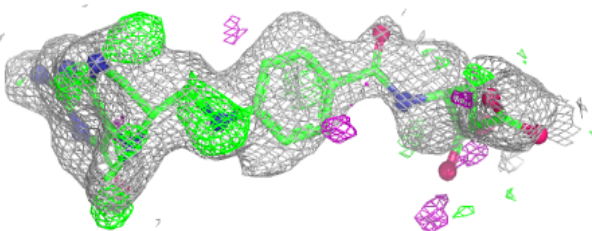
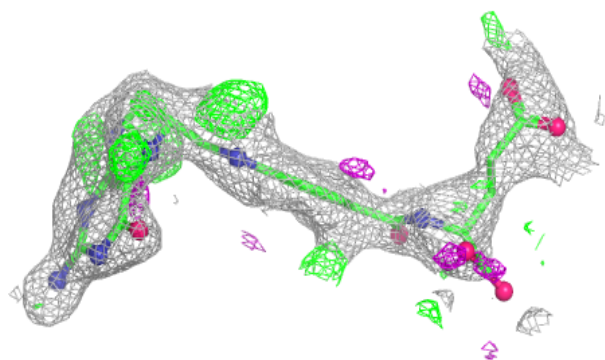
*Continued from previous page...*

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
2	SO4	C	999	5/5	0.91	0.13	36,36,37,37	5
2	SO4	A	998	5/5	0.92	0.12	37,37,38,39	5
4	FAD	C	397	53/53	0.97	0.06	13,16,27,28	0
4	FAD	B	396	53/53	0.98	0.05	15,18,29,31	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.

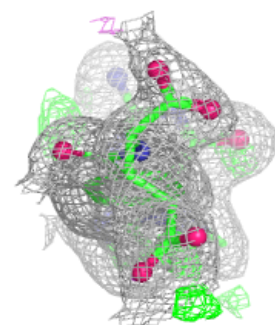
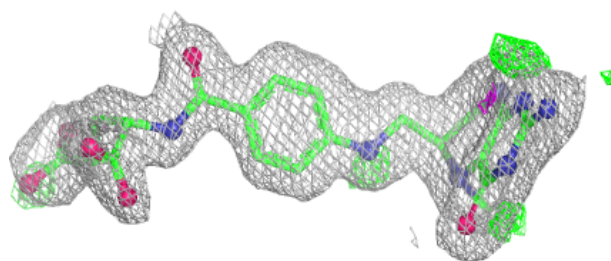
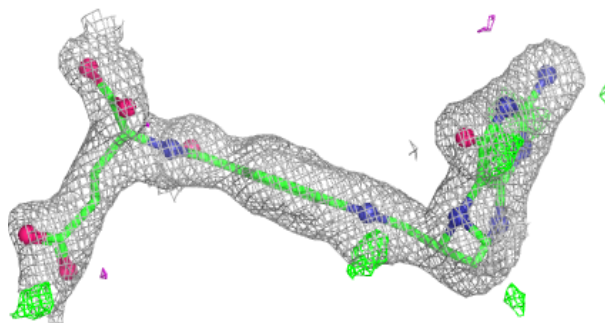
**Electron density around C2F C 997:**

2mF<sub>o</sub>-DF<sub>c</sub> (at 0.7 rmsd) in gray  
mF<sub>o</sub>-DF<sub>c</sub> (at 3 rmsd) in purple (negative)  
and green (positive)

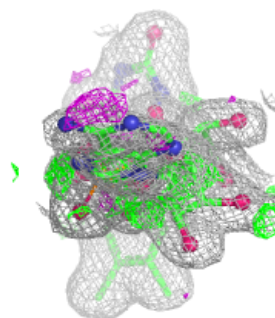
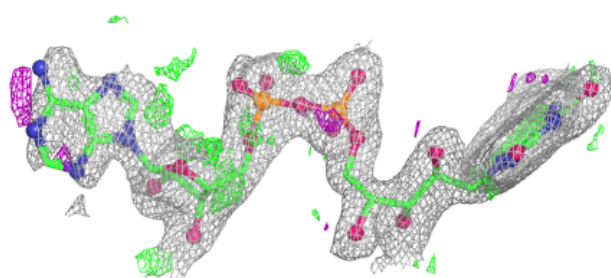
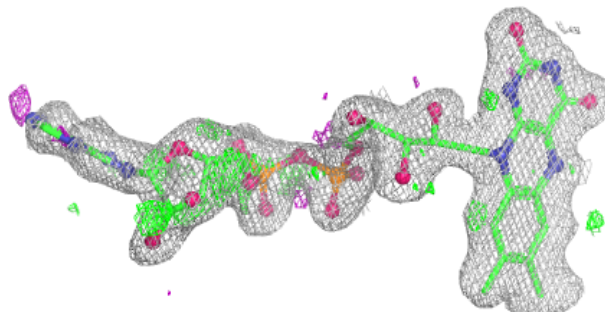


**Electron density around C2F A 995:**

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

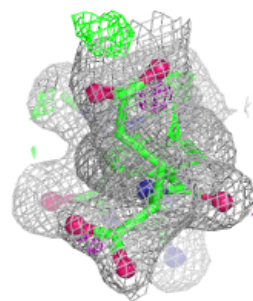
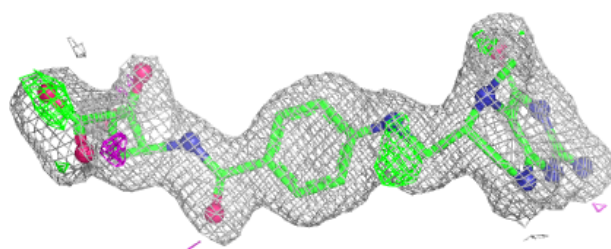
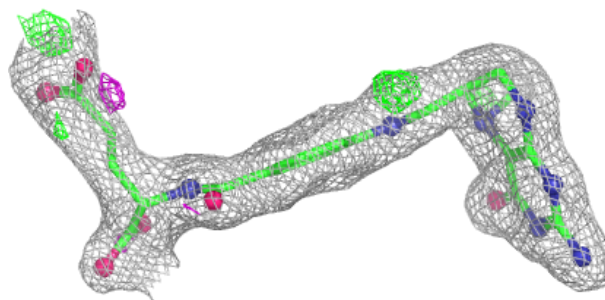
**Electron density around FAD A 395:**

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

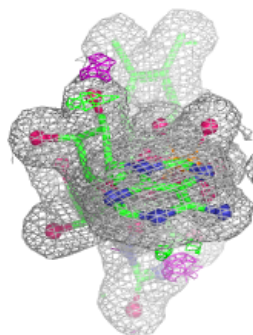
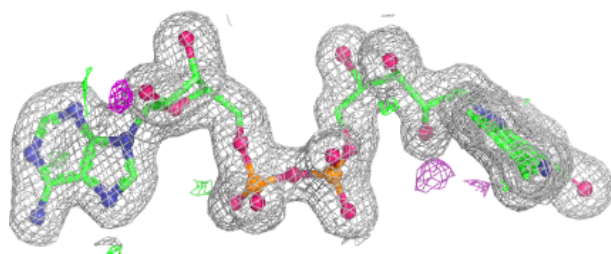
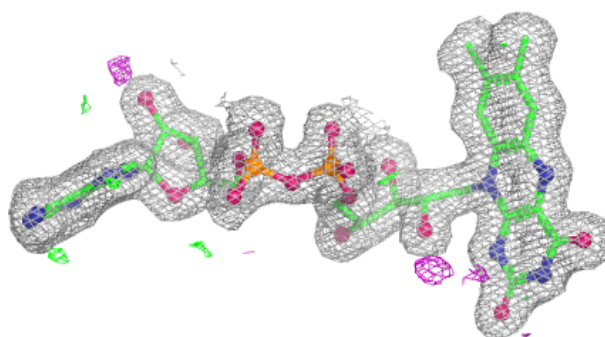


**Electron density around C2F B 996:**

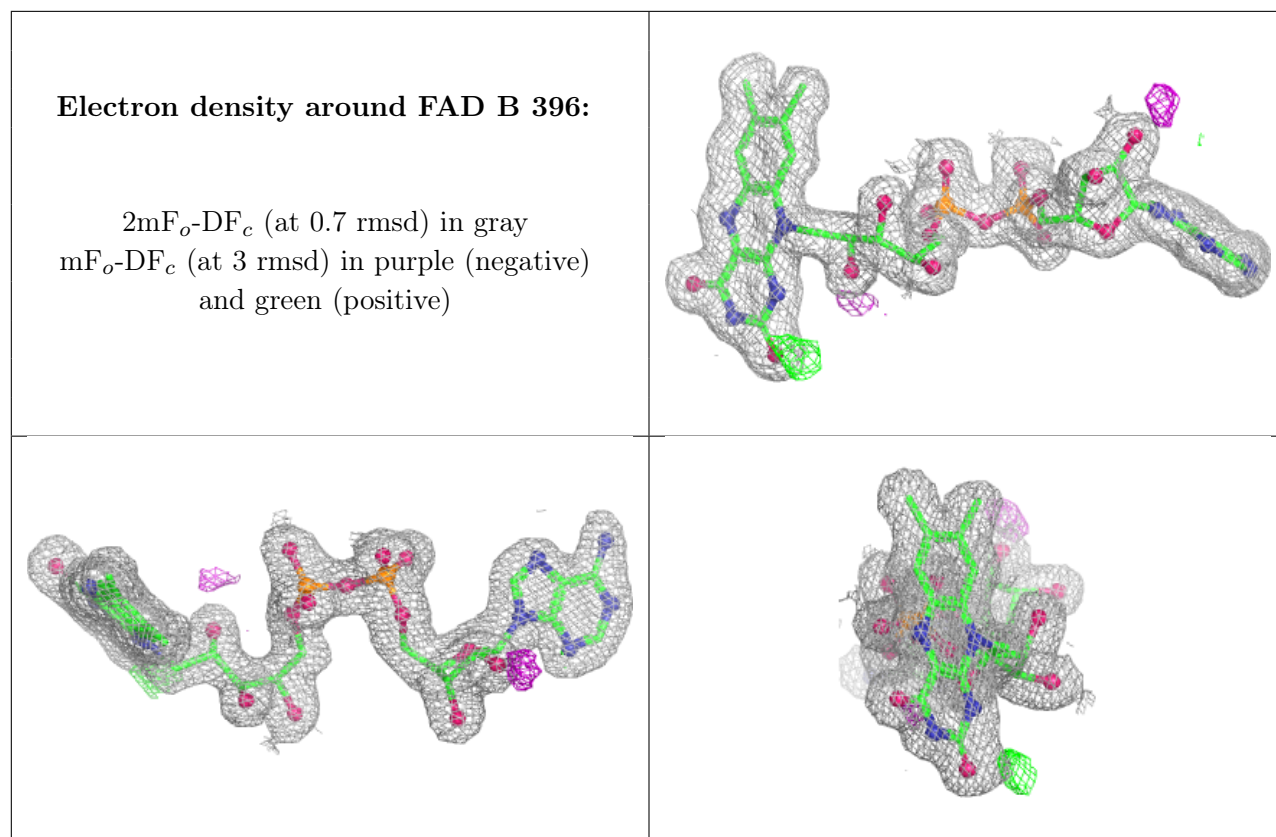
$2mF_o-DF_c$  (at 0.7 rmsd) in gray  
 $mF_o-DF_c$  (at 3 rmsd) in purple (negative)  
and green (positive)

**Electron density around FAD C 397:**

$2mF_o-DF_c$  (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.