



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 20, 2026 – 11:25 AM UTC

PDB ID : 2XRZ / pdb_00002xrz
Title : X-ray structure of archaeal class II CPD photolyase from *Methanosarcina mazei* in complex with intact CPD-lesion
Authors : Kiontke, S.; Geisselbrecht, Y.; Pokorny, R.; Carell, T.; Batschauer, A.; Essen, L.O.
Deposited on : 2010-09-24
Resolution : 2.20 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

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

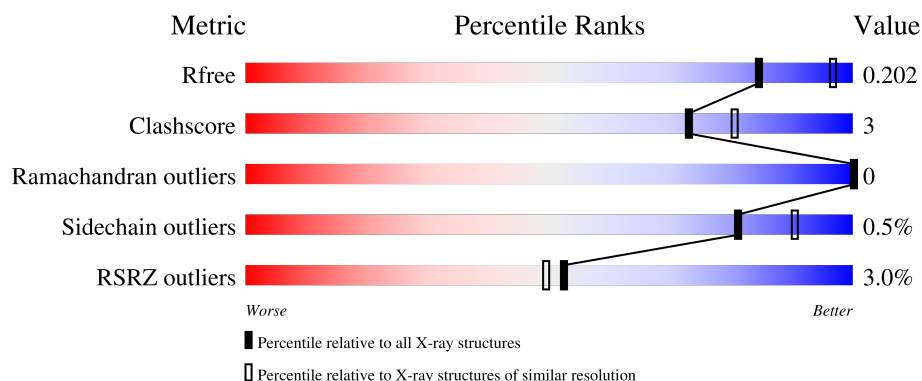
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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.



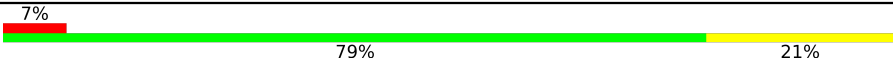
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	6164 (2.20-2.20)
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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	482	 2% 89% 5% 7%
1	B	482	 2% 83% 6% 10%
2	C	14	 7% 57% 21% 21%
2	E	14	 50% 21% 29%

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Mol	Chain	Length	Quality of chain
3	D	14	
3	F	14	

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
7	ACT	B	1463	-	-	X	-

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 8978 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 DEOXYRIBODIPYRIMIDINE PHOTOLYASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	450	Total	C	N	O	S	0	4	0
			3651	2350	611	676	14			
1	B	434	Total	C	N	O	S	0	6	0
			3522	2266	592	649	15			

There are 42 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-17	MET	-	expression tag	UNP Q8PYK9
A	-16	GLY	-	expression tag	UNP Q8PYK9
A	-15	SER	-	expression tag	UNP Q8PYK9
A	-14	SER	-	expression tag	UNP Q8PYK9
A	-13	HIS	-	expression tag	UNP Q8PYK9
A	-12	HIS	-	expression tag	UNP Q8PYK9
A	-11	HIS	-	expression tag	UNP Q8PYK9
A	-10	HIS	-	expression tag	UNP Q8PYK9
A	-9	HIS	-	expression tag	UNP Q8PYK9
A	-8	HIS	-	expression tag	UNP Q8PYK9
A	-7	SER	-	expression tag	UNP Q8PYK9
A	-6	SER	-	expression tag	UNP Q8PYK9
A	-5	GLY	-	expression tag	UNP Q8PYK9
A	-4	LEU	-	expression tag	UNP Q8PYK9
A	-3	VAL	-	expression tag	UNP Q8PYK9
A	-2	PRO	-	expression tag	UNP Q8PYK9
A	-1	ARG	-	expression tag	UNP Q8PYK9
A	0	GLY	-	expression tag	UNP Q8PYK9
A	1	SER	-	expression tag	UNP Q8PYK9
A	2	HIS	-	expression tag	UNP Q8PYK9
A	377	THR	MET	engineered mutation	UNP Q8PYK9
B	-17	MET	-	expression tag	UNP Q8PYK9
B	-16	GLY	-	expression tag	UNP Q8PYK9
B	-15	SER	-	expression tag	UNP Q8PYK9
B	-14	SER	-	expression tag	UNP Q8PYK9

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Chain	Residue	Modelled	Actual	Comment	Reference
B	-13	HIS	-	expression tag	UNP Q8PYK9
B	-12	HIS	-	expression tag	UNP Q8PYK9
B	-11	HIS	-	expression tag	UNP Q8PYK9
B	-10	HIS	-	expression tag	UNP Q8PYK9
B	-9	HIS	-	expression tag	UNP Q8PYK9
B	-8	HIS	-	expression tag	UNP Q8PYK9
B	-7	SER	-	expression tag	UNP Q8PYK9
B	-6	SER	-	expression tag	UNP Q8PYK9
B	-5	GLY	-	expression tag	UNP Q8PYK9
B	-4	LEU	-	expression tag	UNP Q8PYK9
B	-3	VAL	-	expression tag	UNP Q8PYK9
B	-2	PRO	-	expression tag	UNP Q8PYK9
B	-1	ARG	-	expression tag	UNP Q8PYK9
B	0	GLY	-	expression tag	UNP Q8PYK9
B	1	SER	-	expression tag	UNP Q8PYK9
B	2	HIS	-	expression tag	UNP Q8PYK9
B	377	THR	MET	engineered mutation	UNP Q8PYK9

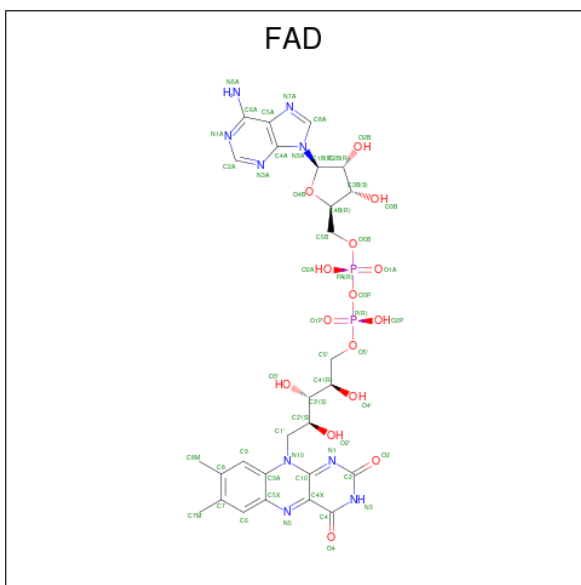
- Molecule 2 is a DNA chain called CPD-COMPRISING OLIGONUCLEOTIDE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	11	Total	C	N	O	P	0	0	0
			242	116	44	71	11			
2	E	10	Total	C	N	O	P	0	0	0
			223	107	41	65	10			

- Molecule 3 is a DNA chain called COUNTERSTRAND-OLIGONUCLEOTIDE.

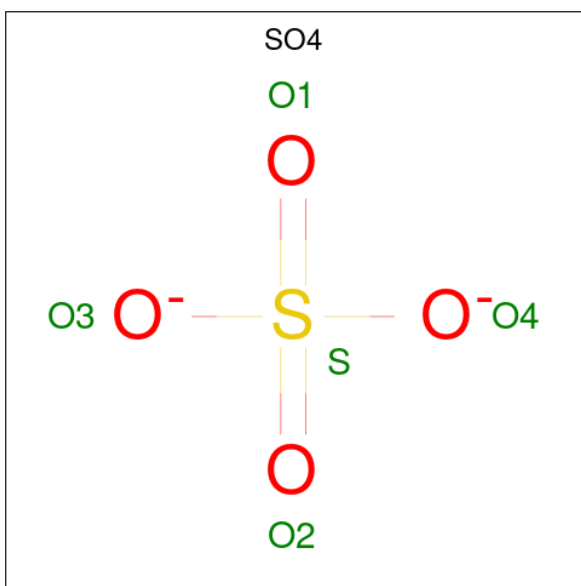
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	14	Total	C	N	O	P	0	0	0
			286	136	56	81	13			
3	F	13	Total	C	N	O	P	0	0	0
			266	126	54	74	12			

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



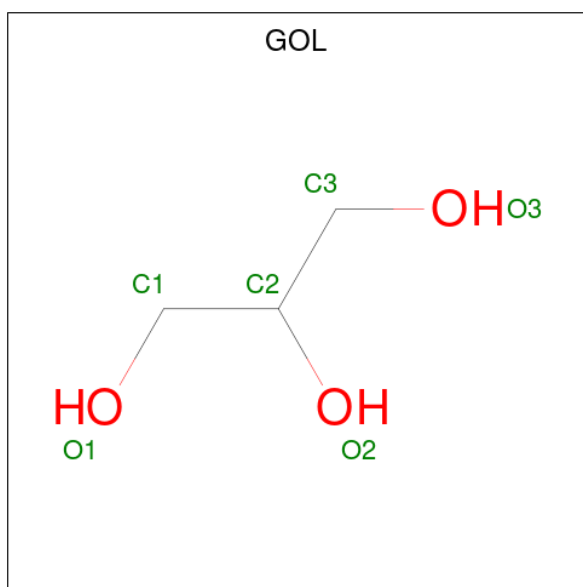
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total 53	C 27	N 9	O 15	P 2	0	0
4	B	1	Total 53	C 27	N 9	O 15	P 2	0	0

- Molecule 5 is SULFATE ION (CCD ID: SO4) (formula: O_4S).



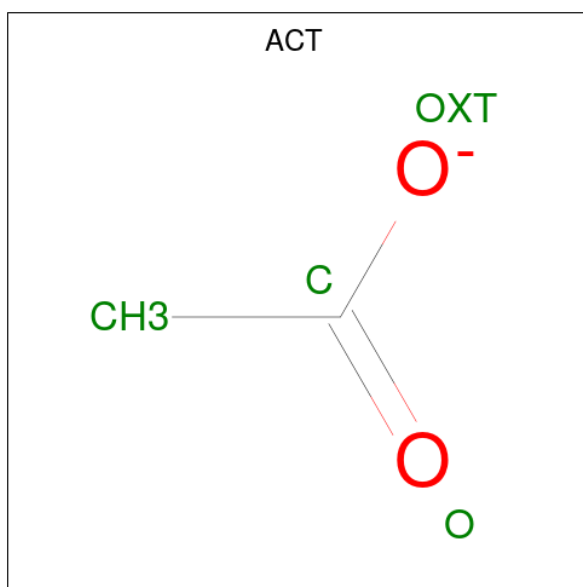
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	O	S	0	0
			5	4	1		

- Molecule 6 is GLYCEROL (CCD ID: GOL) (formula: $\text{C}_3\text{H}_8\text{O}_3$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			6	3	3		
6	A	1	Total	C	O	0	0
			6	3	3		
6	A	1	Total	C	O	0	0
			6	3	3		

- Molecule 7 is ACETATE ION (CCD ID: ACT) (formula: $C_2H_3O_2$).



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

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Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	1	Total C O 4 2 2	0	0
7	A	1	Total C O 4 2 2	0	0
7	A	1	Total C O 4 2 2	0	0
7	B	1	Total C O 4 2 2	0	0
7	B	1	Total C O 4 2 2	0	0

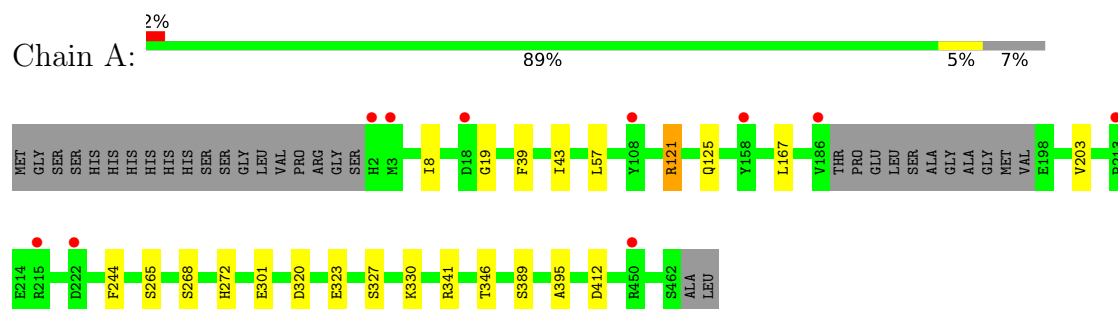
- Molecule 8 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	333	Total O 333 333	0	0
8	B	265	Total O 265 265	0	0
8	C	15	Total O 15 15	0	0
8	D	9	Total O 9 9	0	0
8	E	8	Total O 8 8	0	0
8	F	5	Total O 5 5	0	0

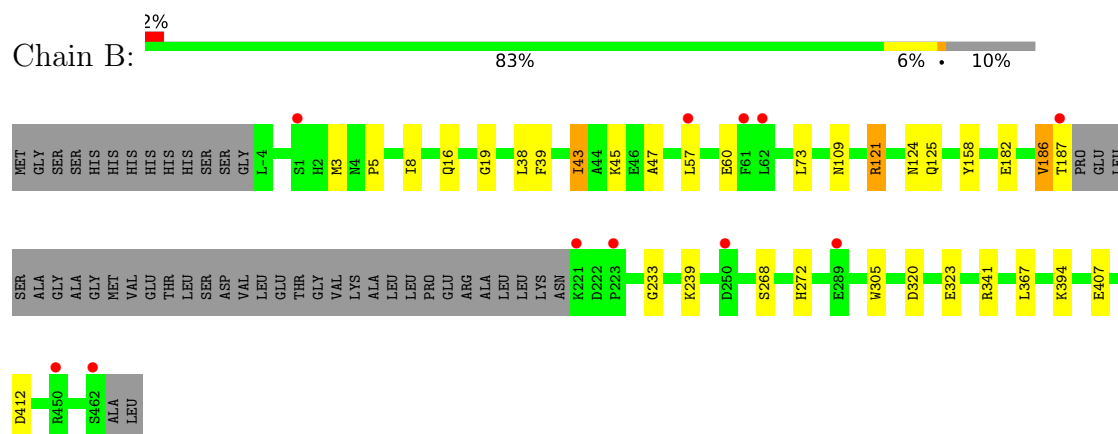
3 Residue-property plots [i](#)

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.

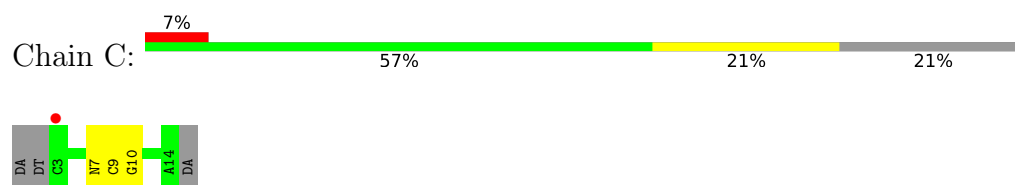
- Molecule 1: DEOXYRIBODIPYRIMIDINE PHOTOLYASE



- Molecule 1: DEOXYRIBODIPYRIMIDINE PHOTOLYASE



- Molecule 2: CPD-COMPRISING OLIGONUCLEOTIDE



- Molecule 2: CPD-COMPRISING OLIGONUCLEOTIDE



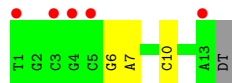
- Molecule 3: COUNTERSTRAND-OLIGONUCLEOTIDE

Chain D:  7% 79% 21%



- Molecule 3: COUNTERSTRAND-OLIGONUCLEOTIDE

Chain F:  36% 71% 21% 7%



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	71.70Å 116.20Å 168.30Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.48 – 2.20 29.48 – 2.20	Depositor EDS
% Data completeness (in resolution range)	99.9 (29.48-2.20) 99.9 (29.48-2.20)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.35 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.170 , 0.208 (Not available) , 0.202	Depositor DCC
R_{free} test set	1094 reflections (1.52%)	wwPDB-VP
Wilson B-factor (Å ²)	32.5	Xtriage
Anisotropy	0.296	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 57.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	8978	wwPDB-VP
Average B, all atoms (Å ²)	58.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.42% 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: TT, GOL, FAD, ACT, SO4

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	0.82	0/3763	0.89	3/5094 (0.1%)
1	B	0.76	0/3640	0.84	5/4930 (0.1%)
2	C	0.37	0/227	0.93	0/345
2	E	0.40	0/206	1.06	2/313 (0.6%)
3	D	0.37	0/321	0.98	0/494
3	F	0.34	0/299	0.92	0/460
All	All	0.75	0/8456	0.88	10/11636 (0.1%)

There are no bond length outliers.

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	E	12	DG	C5'-C4'-O4'	5.47	117.61	109.40
1	B	233	GLY	N-CA-C	5.30	116.98	111.95
1	B	121	ARG	CB-CA-C	-5.25	102.41	110.81
2	E	11	DC	O3'-P-O5'	-5.19	96.21	104.00
1	B	43	ILE	CB-CA-C	-5.13	105.31	111.88
1	A	19	GLY	CA-C-N	5.11	125.01	119.85
1	A	19	GLY	C-N-CA	5.11	125.01	119.85
1	B	186	VAL	CA-C-N	5.01	130.73	121.70
1	B	186	VAL	C-N-CA	5.01	130.73	121.70
1	A	121	ARG	CB-CA-C	-5.00	102.80	110.81

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	3651	0	3540	23	0
1	B	3522	0	3396	25	0
2	C	242	0	136	1	0
2	E	223	0	125	3	0
3	D	286	0	158	2	0
3	F	266	0	146	2	0
4	A	53	0	31	2	0
4	B	53	0	31	1	0
5	A	5	0	0	0	0
6	A	18	0	24	1	0
7	A	16	0	12	3	0
7	B	8	0	6	3	0
8	A	333	0	0	3	0
8	B	265	0	0	3	0
8	C	15	0	0	0	0
8	D	9	0	0	1	0
8	E	8	0	0	0	0
8	F	5	0	0	0	0
All	All	8978	0	7605	51	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 3.

All (51) 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:A:8:ILE:HD13	1:A:39[B]:PHE:CZ	1.99	0.98
1:A:8:ILE:CD1	1:A:39[B]:PHE:CE2	2.49	0.95
1:A:39[B]:PHE:CE2	1:A:43:ILE:HD11	2.05	0.91
1:A:8:ILE:HD13	1:A:39[B]:PHE:CE2	2.07	0.89
1:B:3[A]:MET:HE1	1:B:38:LEU:HB3	1.63	0.78
1:A:125:GLN:HE22	1:B:341:ARG:H	1.36	0.74
1:B:43:ILE:CG2	7:B:1463:ACT:H3	2.24	0.67
1:A:341:ARG:H	1:B:125:GLN:HE22	1.43	0.66
4:A:998:FAD:N1A	8:A:2296:HOH:O	2.30	0.63

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:124[B]:ASN:ND2	8:B:2087:HOH:O	2.30	0.63
1:A:272:HIS:HD2	1:A:412:ASP:OD1	1.82	0.63
1:A:301:GLU:OE2	7:A:1470:ACT:H1	1.99	0.62
1:B:5:PRO:HA	1:B:8:ILE:HD12	1.84	0.60
1:A:320:ASP:OD2	7:A:1467:ACT:H1	2.03	0.58
1:A:39[B]:PHE:HE2	1:A:43:ILE:HD11	1.66	0.57
1:A:323[B]:GLU:OE1	1:A:330:LYS:NZ	2.38	0.56
1:B:186:VAL:HG12	1:B:187:THR:HG23	1.88	0.56
1:B:45:LYS:NZ	1:B:182:GLU:OE1	2.31	0.53
1:A:323[B]:GLU:OE2	1:B:323:GLU:OE1	2.26	0.53
1:A:323[B]:GLU:HG2	8:A:2230:HOH:O	2.09	0.52
1:B:394:LYS:NZ	8:B:2220:HOH:O	2.43	0.51
1:B:305:TRP:CE2	2:E:7:TT:H5A2	2.46	0.51
1:B:272:HIS:HD2	1:B:412:ASP:OD1	1.93	0.51
3:D:12:DG:OP1	8:D:2009:HOH:O	2.19	0.51
1:A:121:ARG:NH2	1:A:320:ASP:OD1	2.34	0.50
1:A:346:THR:HG21	1:B:60:GLU:HG2	1.95	0.49
7:A:1469:ACT:H1	8:A:2055:HOH:O	2.10	0.49
1:B:19:GLY:HA3	1:B:109:ASN:O	2.14	0.48
1:B:121:ARG:NH2	1:B:320:ASP:OD1	2.43	0.47
2:C:9:DC:H2'	2:C:10:DG:C8	2.49	0.47
1:B:16:GLN:NE2	7:B:1463:ACT:H2	2.31	0.46
3:F:6:DG:H2''	3:F:7:DA:C8	2.51	0.46
1:B:3[A]:MET:HE1	1:B:38:LEU:CB	2.42	0.45
2:E:11:DC:H2'''	2:E:12:DG:C8	2.51	0.45
1:B:124[B]:ASN:ND2	8:B:2086:HOH:O	2.48	0.45
1:A:327:SER:HB2	6:A:1465:GOL:H31	1.98	0.45
1:B:158:TYR:CZ	3:F:10:DC:H4'	2.52	0.45
1:B:43:ILE:HD13	1:B:43:ILE:HG21	1.70	0.44
1:A:8:ILE:HD12	1:A:39[B]:PHE:CE2	2.48	0.44
1:B:3[B]:MET:HE2	1:B:39:PHE:HB2	2.00	0.44
1:B:305:TRP:CD2	2:E:7:TT:H5A2	2.53	0.44
1:A:389[A]:SER:OG	1:A:395:ALA:HB2	2.18	0.44
1:A:268:SER:HB3	4:A:998:FAD:H5'2	2.00	0.43
1:B:47:ALA:HB2	7:B:1463:ACT:H1	2.00	0.42
1:B:268:SER:HB3	4:B:998:FAD:H5'2	2.01	0.42
1:A:8:ILE:HD12	1:A:39[B]:PHE:CD2	2.54	0.42
1:A:121:ARG:HH22	1:A:320:ASP:CG	2.24	0.42
1:B:367:LEU:HD13	1:B:407:GLU:CD	2.46	0.41
1:A:57:LEU:HD13	1:A:203:VAL:HG11	2.03	0.41
1:A:244:PHE:CD1	1:A:265:SER:HA	2.57	0.40

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:D:5:DC:H2''	3:D:6:DG:C8	2.56	0.40

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	450/482 (93%)	442 (98%)	8 (2%)	0	100	100
1	B	436/482 (90%)	428 (98%)	8 (2%)	0	100	100
All	All	886/964 (92%)	870 (98%)	16 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	388/416 (93%)	387 (100%)	1 (0%)	86	93
1	B	373/416 (90%)	370 (99%)	3 (1%)	73	85
All	All	761/832 (92%)	757 (100%)	4 (0%)	81	90

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	167	LEU
1	B	57	LEU
1	B	73	LEU
1	B	239	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (16) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	2	HIS
1	A	16	GLN
1	A	48	ASN
1	A	125	GLN
1	A	154	GLN
1	A	156	HIS
1	A	161	HIS
1	A	272	HIS
1	A	316	ASN
1	A	343	HIS
1	B	16	GLN
1	B	125	GLN
1	B	154	GLN
1	B	272	HIS
1	B	279	GLN
1	B	343	HIS

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

2 non-standard protein/DNA/RNA residues 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
2	TT	C	7	2	40,43,44	1.04	2 (5%)	58,69,72	1.50	13 (22%)
2	TT	E	7	2	40,43,44	0.91	3 (7%)	58,69,72	1.83	9 (15%)

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
2	TT	C	7	2	-	8/18/105/106	0/5/6/6
2	TT	E	7	2	-	7/18/105/106	0/5/6/6

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	7	TT	C1'-N1	3.87	1.50	1.45
2	E	7	TT	C1'-N1	3.24	1.50	1.45
2	E	7	TT	C1R-N1T	3.08	1.49	1.45
2	C	7	TT	O5'-C5'	-2.28	1.37	1.44
2	E	7	TT	C5-C6	2.09	1.57	1.55

All (22) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	E	7	TT	C7-O3'-C3'	8.73	130.26	115.05
2	C	7	TT	O4'-C1'-N1	4.54	114.03	108.65
2	E	7	TT	C2'-C1'-N1	4.26	121.35	115.59
2	E	7	TT	C6-C6T-N1T	3.91	133.12	118.51
2	E	7	TT	O4R-C1R-N1T	3.51	112.82	108.65
2	E	7	TT	C2R-C1R-N1T	3.21	119.93	115.59
2	C	7	TT	C6T-C6-N1	-3.16	106.68	118.51
2	C	7	TT	O4R-C1R-C2R	-3.07	100.51	106.25
2	C	7	TT	C6-C6T-N1T	2.80	128.97	118.51
2	C	7	TT	O2-C2-N1	-2.79	119.26	123.44
2	E	7	TT	C5T-C6T-N1T	2.67	119.20	115.65
2	C	7	TT	O4R-C1R-N1T	2.61	111.74	108.65
2	C	7	TT	C5M-C5T-C5	-2.59	108.98	116.61
2	C	7	TT	O2T-C2T-N3T	-2.47	116.92	121.49
2	C	7	TT	C5-C5T-C4T	2.46	120.82	112.84
2	C	7	TT	C2R-C1R-N1T	2.44	118.88	115.59
2	C	7	TT	C5T-C6T-N1T	2.32	118.73	115.65

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	E	7	TT	O4R-C1R-C2R	-2.31	101.92	106.25
2	E	7	TT	O4'-C1'-N1	2.20	111.26	108.65
2	C	7	TT	C5A-C5-C5T	2.06	122.69	116.61
2	C	7	TT	C7-O3'-C3'	2.03	118.59	115.05
2	E	7	TT	C5M-C5T-C5	-2.03	110.63	116.61

There are no chirality outliers.

All (15) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	C	7	TT	C3'-C4'-C5'-O5'
2	E	7	TT	C2'-C1'-N1-C6
2	E	7	TT	C2'-C1'-N1-C2
2	C	7	TT	C2'-C1'-N1-C6
2	E	7	TT	O4'-C1'-N1-C2
2	C	7	TT	C2'-C1'-N1-C2
2	C	7	TT	O4'-C4'-C5'-O5'
2	E	7	TT	O4'-C1'-N1-C6
2	C	7	TT	O4'-C1'-N1-C6
2	C	7	TT	O4'-C1'-N1-C2
2	C	7	TT	C2R-C1R-N1T-C6T
2	E	7	TT	O4R-C1R-N1T-C6T
2	C	7	TT	O4R-C1R-N1T-C6T
2	E	7	TT	O4R-C1R-N1T-C2T
2	E	7	TT	C2R-C1R-N1T-C6T

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	E	7	TT	2	0

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

12 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	$\# Z > 2$
7	ACT	B	1464	-	3,3,3	0.78	0	3,3,3	1.64	1 (33%)
7	ACT	A	1469	-	3,3,3	0.85	0	3,3,3	1.75	2 (66%)
6	GOL	A	1464	-	5,5,5	0.52	0	5,5,5	0.30	0
7	ACT	A	1467	-	3,3,3	0.87	0	3,3,3	1.68	1 (33%)
7	ACT	A	1470	-	3,3,3	0.81	0	3,3,3	1.38	0
6	GOL	A	1465	-	5,5,5	0.43	0	5,5,5	0.55	0
7	ACT	A	1468	-	3,3,3	0.94	0	3,3,3	1.49	1 (33%)
4	FAD	B	998	-	58,58,58	1.26	9 (15%)	85,89,89	1.57	15 (17%)
7	ACT	B	1463	-	3,3,3	0.78	0	3,3,3	1.56	0
6	GOL	A	1466	-	5,5,5	0.41	0	5,5,5	0.34	0
4	FAD	A	998	-	58,58,58	1.18	6 (10%)	85,89,89	1.51	15 (17%)
5	SO4	A	1463	-	4,4,4	0.20	0	6,6,6	0.42	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
6	GOL	A	1464	-	-	2/4/4/4	-
6	GOL	A	1465	-	-	0/4/4/4	-
4	FAD	B	998	-	-	3/34/50/50	0/6/6/6
6	GOL	A	1466	-	-	2/4/4/4	-
4	FAD	A	998	-	-	2/34/50/50	0/6/6/6

All (15) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	998	FAD	C4X-N5	4.20	1.39	1.30
4	A	998	FAD	C4X-N5	4.02	1.39	1.30
4	B	998	FAD	C10-N1	2.85	1.39	1.33
4	A	998	FAD	C10-N1	2.72	1.38	1.33

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	998	FAD	C2A-N3A	2.68	1.38	1.33
4	A	998	FAD	C2A-N3A	2.62	1.38	1.33
4	B	998	FAD	C2A-N1A	2.60	1.38	1.33
4	A	998	FAD	P-O3P	2.45	1.62	1.59
4	B	998	FAD	PA-O3P	2.43	1.62	1.59
4	B	998	FAD	C1'-C2'	2.39	1.56	1.52
4	A	998	FAD	C8A-N7A	2.37	1.36	1.31
4	B	998	FAD	P-O3P	2.32	1.62	1.59
4	A	998	FAD	C2A-N1A	2.29	1.38	1.33
4	B	998	FAD	C8A-N7A	2.19	1.35	1.31
4	B	998	FAD	C5A-N7A	-2.01	1.35	1.39

All (35) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	998	FAD	N3A-C2A-N1A	-5.03	120.96	128.58
4	B	998	FAD	N3A-C2A-N1A	-5.03	120.97	128.58
4	B	998	FAD	C5A-C4A-N3A	-4.04	121.15	126.72
4	A	998	FAD	C5A-C4A-N3A	-3.95	121.28	126.72
4	B	998	FAD	O2P-P-O3P	3.86	117.69	107.27
4	B	998	FAD	N9A-C8A-N7A	-3.81	108.53	113.94
4	B	998	FAD	C5A-N7A-C8A	3.59	109.10	103.45
4	A	998	FAD	C4-N3-C2	-3.10	120.13	125.64
4	A	998	FAD	N9A-C8A-N7A	-3.03	109.64	113.94
4	A	998	FAD	O2P-P-O3P	2.99	115.35	107.27
4	B	998	FAD	C2A-N3A-C4A	2.98	119.11	111.83
4	A	998	FAD	C2A-N3A-C4A	2.85	118.80	111.83
4	B	998	FAD	C4A-C5A-N7A	-2.85	107.32	110.58
4	A	998	FAD	O4B-C1B-N9A	2.77	113.41	108.09
4	B	998	FAD	C4-N3-C2	-2.71	120.82	125.64
4	A	998	FAD	C5X-C9A-N10	2.68	120.39	117.97
4	B	998	FAD	C4X-C10-N10	2.65	120.28	116.48
4	B	998	FAD	C10-C4X-N5	-2.61	119.49	124.81
4	B	998	FAD	C4X-C4-N3	2.57	119.79	113.25
4	B	998	FAD	C9A-C5X-N5	-2.54	119.75	122.45
4	A	998	FAD	C4X-C10-N10	2.51	120.07	116.48
4	A	998	FAD	C5A-N7A-C8A	2.50	107.38	103.45
4	B	998	FAD	C5X-C9A-N10	2.44	120.17	117.97
4	A	998	FAD	C4X-C4-N3	2.31	119.14	113.25
4	A	998	FAD	N3A-C4A-N9A	2.31	131.10	127.17
4	B	998	FAD	C4X-C10-N1	-2.31	118.93	124.59
4	A	998	FAD	O4-C4-C4X	-2.27	120.55	126.53

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	998	FAD	N3A-C4A-N9A	2.22	130.95	127.17
7	A	1469	ACT	OXT-C-O	-2.21	113.84	122.03
7	A	1467	ACT	OXT-C-O	-2.15	114.06	122.03
4	A	998	FAD	C10-C4X-N5	-2.11	120.50	124.81
7	A	1469	ACT	OXT-C-CH3	2.07	123.73	115.05
4	A	998	FAD	C9A-C5X-N5	-2.02	120.31	122.45
7	A	1468	ACT	OXT-C-O	-2.02	114.55	122.03
7	B	1464	ACT	OXT-C-CH3	2.01	123.49	115.05

There are no chirality outliers.

All (9) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	1466	GOL	O1-C1-C2-C3
6	A	1464	GOL	O2-C2-C3-O3
6	A	1466	GOL	O1-C1-C2-O2
6	A	1464	GOL	C1-C2-C3-O3
4	B	998	FAD	C5B-O5B-PA-O3P
4	A	998	FAD	C4'-C5'-O5'-P
4	B	998	FAD	C4'-C5'-O5'-P
4	A	998	FAD	P-O3P-PA-O2A
4	B	998	FAD	P-O3P-PA-O2A

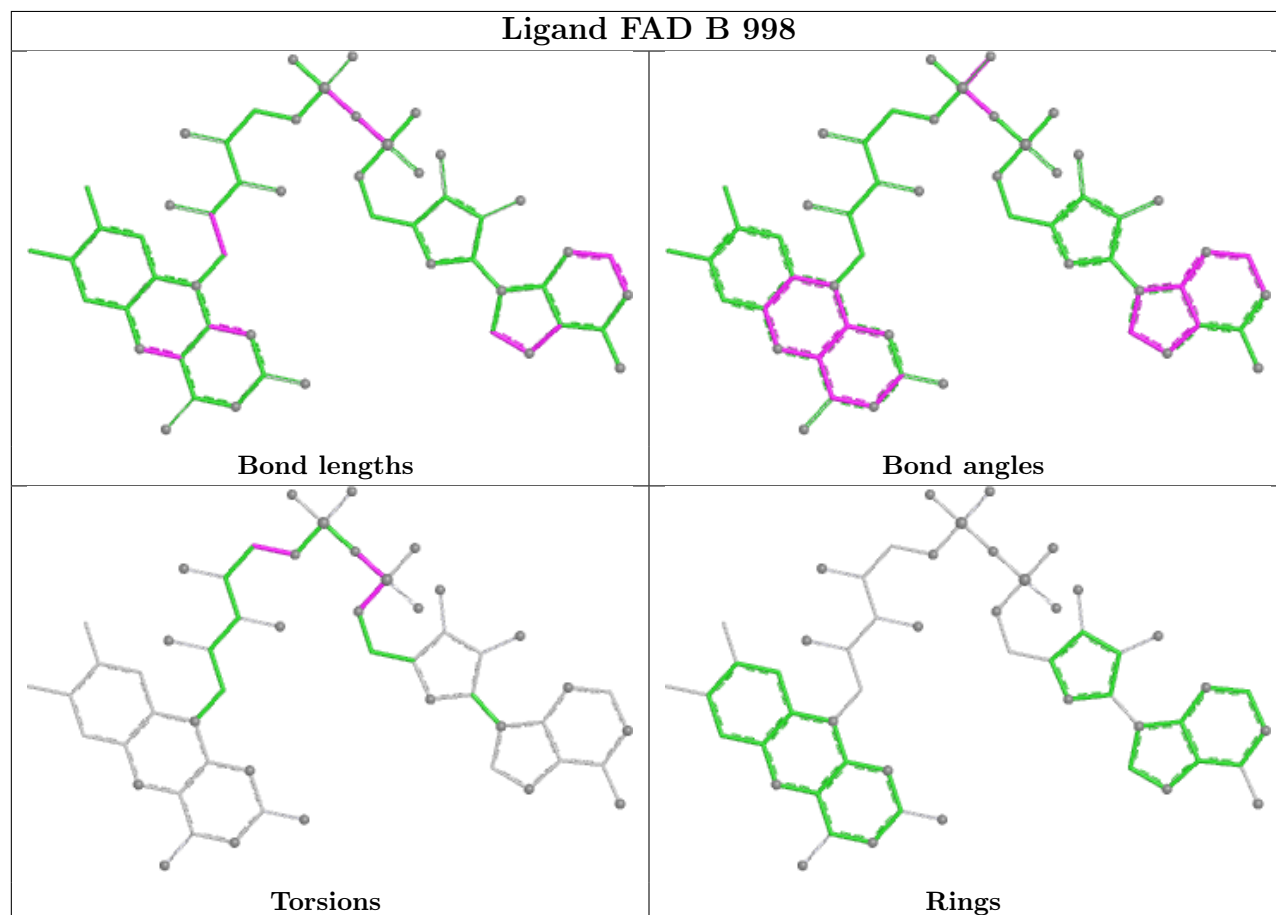
There are no ring outliers.

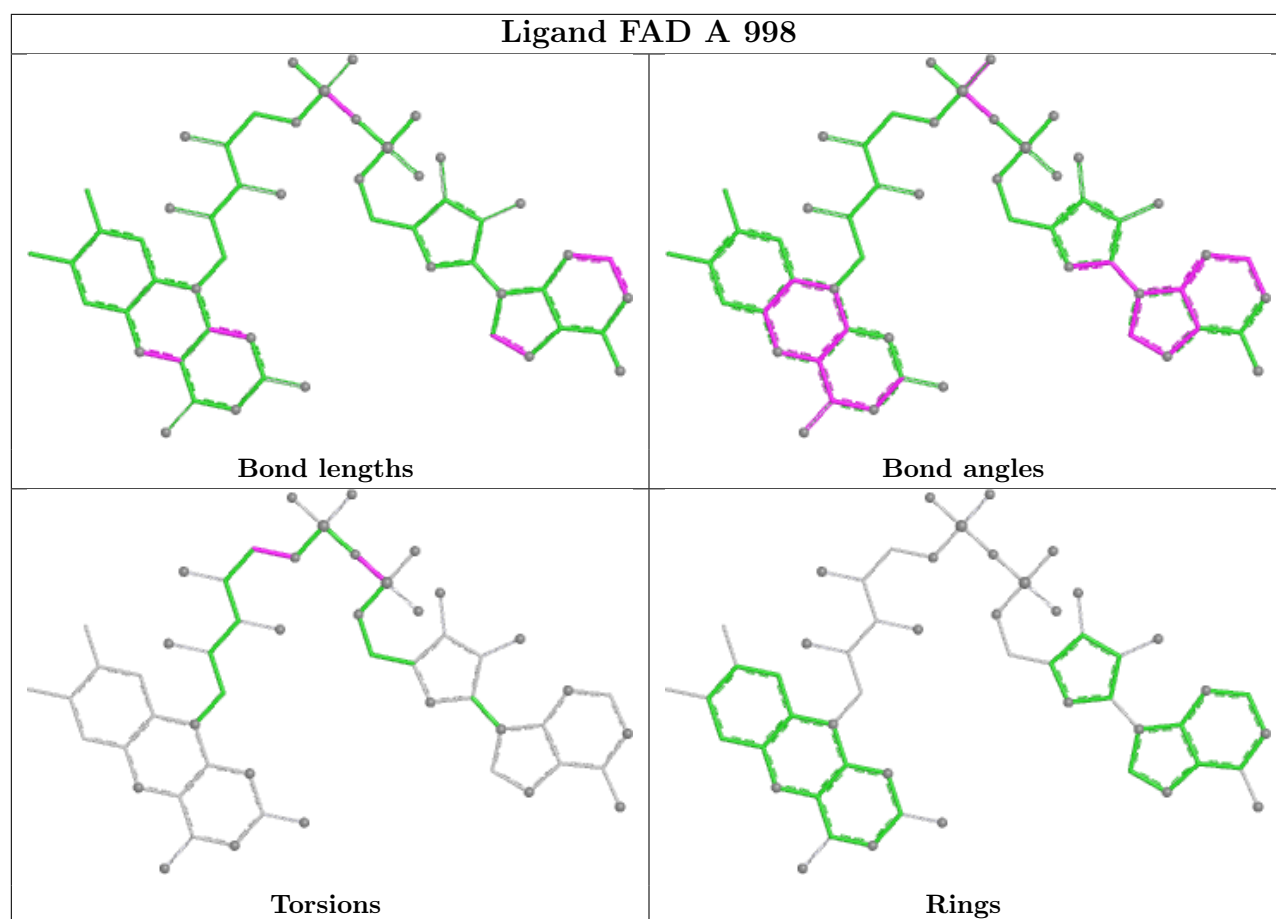
7 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
7	A	1469	ACT	1	0
7	A	1467	ACT	1	0
7	A	1470	ACT	1	0
6	A	1465	GOL	1	0
4	B	998	FAD	1	0
7	B	1463	ACT	3	0
4	A	998	FAD	2	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.





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	450/482 (93%)	-0.09	10 (2%) 62 59	24, 46, 74, 85	4 (0%)
1	B	434/482 (90%)	0.10	11 (2%) 58 55	26, 54, 83, 98	6 (1%)
2	C	10/14 (71%)	0.77	1 (10%) 12 10	46, 93, 133, 137	0
2	E	9/14 (64%)	0.78	0 100 100	62, 90, 120, 131	0
3	D	14/14 (100%)	1.23	1 (7%) 22 19	65, 97, 126, 148	0
3	F	13/14 (92%)	1.64	5 (38%) 1 0	79, 111, 140, 167	0
All	All	930/1020 (91%)	0.06	28 (3%) 52 49	24, 51, 88, 167	10 (1%)

All (28) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	F	13	DA	3.6
1	A	2	HIS	3.3
1	B	187	THR	3.1
1	B	289	GLU	3.1
3	D	14	DT	3.1
1	B	61	PHE	3.0
3	F	4	DG	3.0
3	F	5	DC	2.9
1	B	462	SER	2.9
3	F	3	DC	2.8
1	A	108	TYR	2.8
1	A	158	TYR	2.7
1	B	250	ASP	2.7
1	A	18	ASP	2.7
1	B	221	LYS	2.7
1	B	223	PRO	2.6
1	B	62	LEU	2.6
1	A	222	ASP	2.6
1	B	450	ARG	2.4

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Mol	Chain	Res	Type	RSRZ
1	A	215	ARG	2.3
1	A	3	MET	2.2
1	A	186	VAL	2.1
1	A	213	PRO	2.1
1	B	1	SER	2.1
3	F	1	DT	2.1
2	C	3	DC	2.1
1	A	450	ARG	2.1
1	B	57	LEU	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [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(Å ²)	Q<0.9
2	TT	E	7	38/39	0.95	0.09	55,62,79,84	0
2	TT	C	7	38/39	0.97	0.07	40,44,50,53	0

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(Å ²)	Q<0.9
7	ACT	A	1469	4/4	0.81	0.17	76,76,76,76	0
7	ACT	A	1467	4/4	0.83	0.17	67,67,67,67	0
6	GOL	A	1465	6/6	0.90	0.14	59,61,62,63	0
6	GOL	A	1466	6/6	0.90	0.18	85,87,87,87	0
6	GOL	A	1464	6/6	0.91	0.15	54,55,56,56	0
7	ACT	B	1464	4/4	0.91	0.24	59,59,59,60	0
7	ACT	A	1470	4/4	0.92	0.17	86,86,86,87	0

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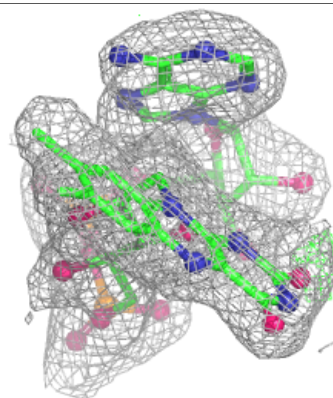
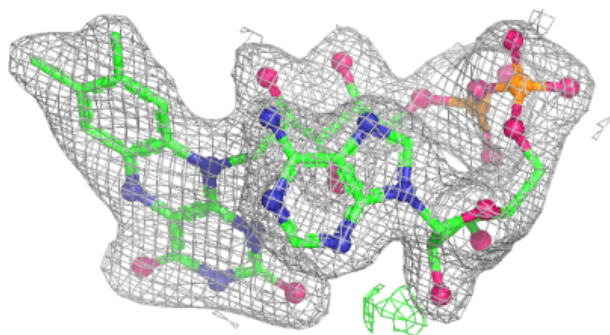
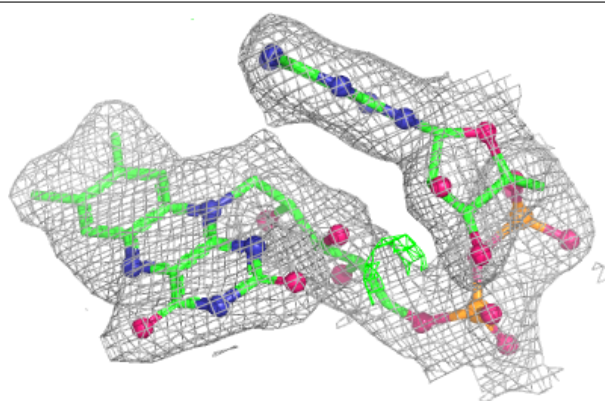
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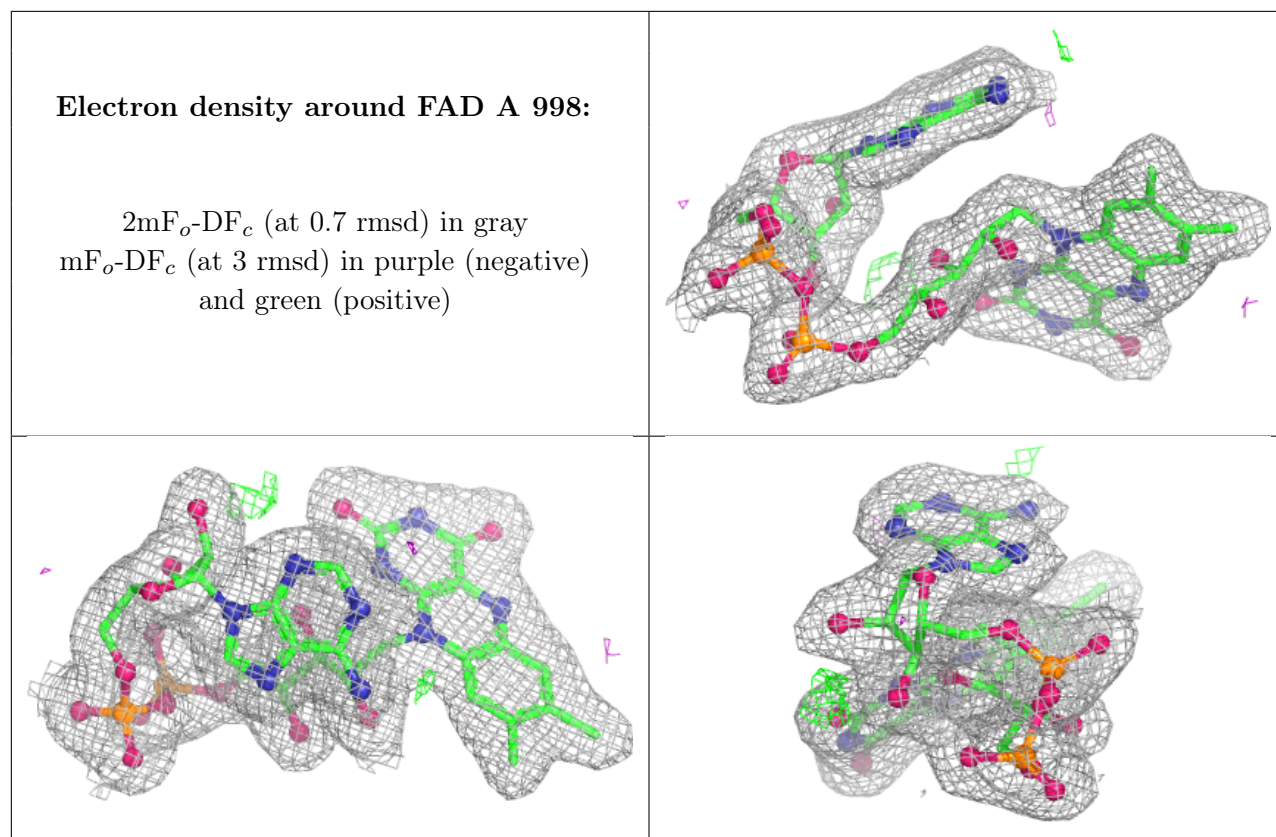
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
7	ACT	B	1463	4/4	0.94	0.19	73,73,73,73	0
7	ACT	A	1468	4/4	0.94	0.13	50,50,51,51	0
4	FAD	B	998	53/53	0.97	0.06	42,50,57,59	0
5	SO4	A	1463	5/5	0.98	0.06	53,53,57,57	0
4	FAD	A	998	53/53	0.98	0.05	31,36,38,40	0

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 998:

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.