



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 07:07 AM UTC

PDB ID : 3AD7 / pdb_00003ad7
Title : Heterotetrameric Sarcosine Oxidase from *Corynebacterium* sp. U-96 in complex with methylthio acetate
Authors : Suzuki, H.; Moriguchi, T.; Ida, K.
Deposited on : 2010-01-15
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

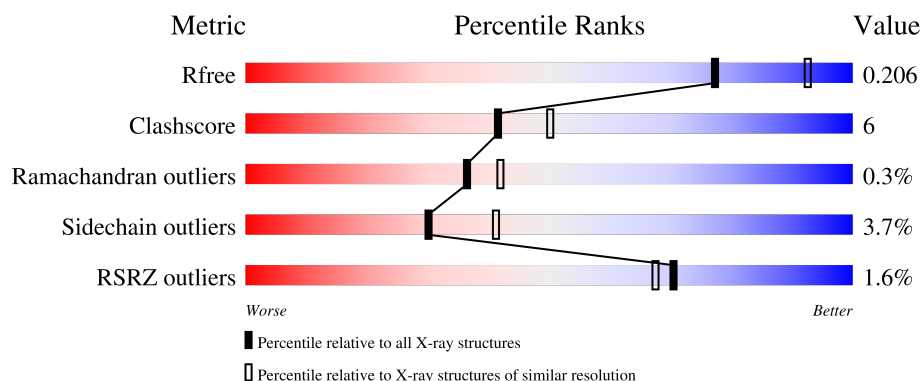
1 Overall quality at a glance

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	964	2% 88% 11% .
2	B	404	% 88% 10% .
3	C	203	2% 85% 11% .
4	D	99	% 89% 8% .

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
8	FMN	B	406	-	-	X	-

2 Entry composition [i](#)

There are 11 unique types of molecules in this entry. The entry contains 13623 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 Subunit alpha of sarcosine oxidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	963	Total	C	N	O	S	0	0	0
			7229	4507	1287	1413	22			

- Molecule 2 is a protein called Subunit beta of sarcosine oxidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	404	Total	C	N	O	S	0	0	0
			3108	1981	541	576	10			

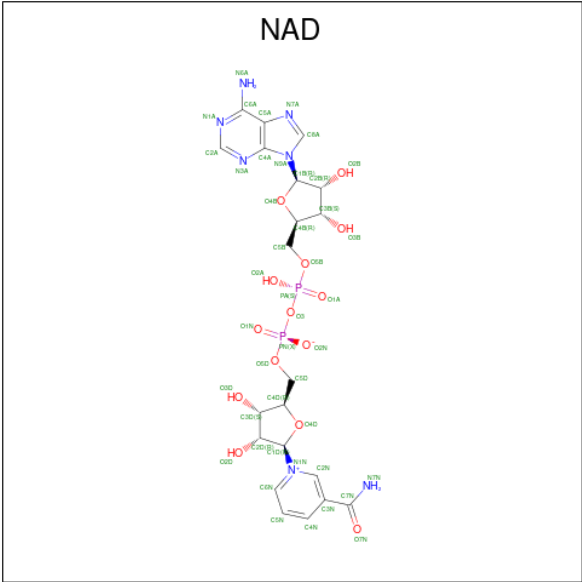
- Molecule 3 is a protein called Subunit gamma of sarcosine oxidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	195	Total	C	N	O	S	0	0	0
			1433	902	257	271	3			

- Molecule 4 is a protein called Subunit delta of sarcosine oxidase.

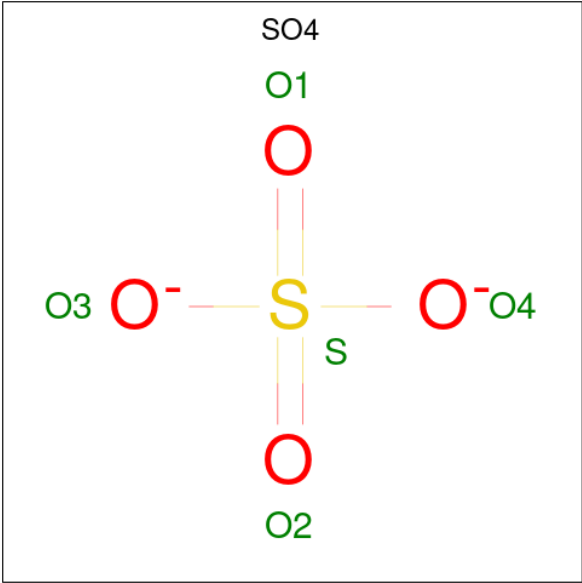
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	91	Total	C	N	O	S	0	0	0
			749	476	135	133	5			

- Molecule 5 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (CCD ID: NAD) (formula: C₂₁H₂₇N₇O₁₄P₂).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
5	A	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

- Molecule 6 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



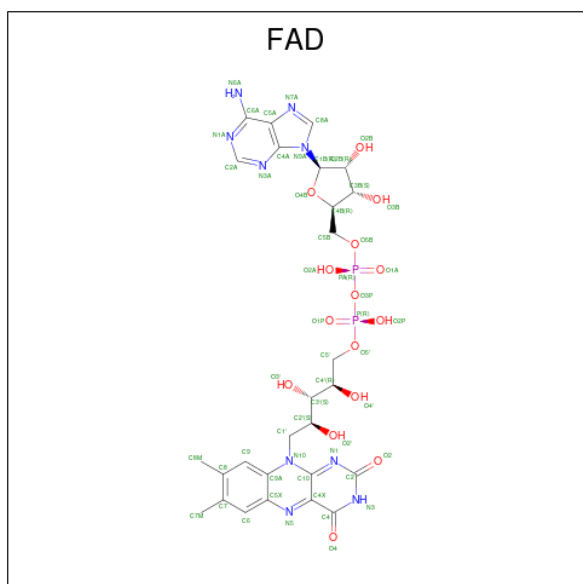
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		

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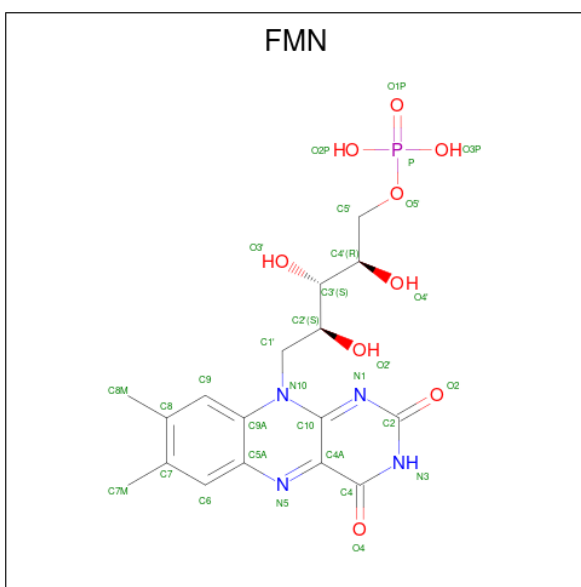
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	B	1	Total	O	S	0	0
			5	4	1		
6	B	1	Total	O	S	0	0
			5	4	1		
6	C	1	Total	O	S	0	0
			5	4	1		
6	D	1	Total	O	S	0	0
			5	4	1		

- Molecule 7 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$).



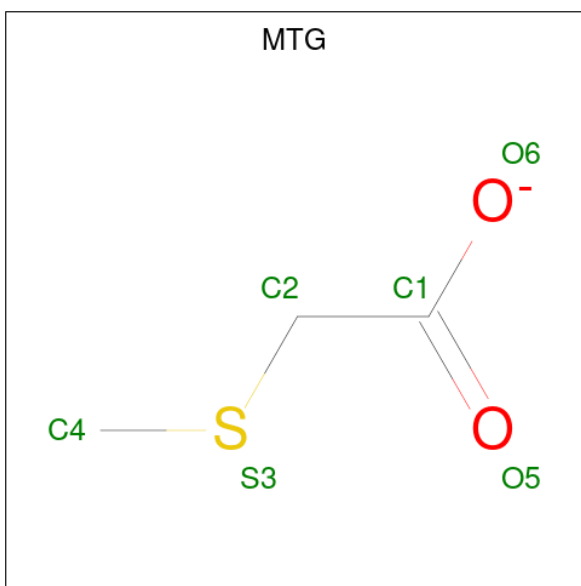
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
7	B	1	Total	C	N	O	P	0
			53	27	9	15	2	0

- Molecule 8 is FLAVIN MONONUCLEOTIDE (CCD ID: FMN) (formula: $C_{17}H_{21}N_4O_9P$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
8	B	1	Total	C	N	O	P	0	0
			31	17	4	9	1		

- Molecule 9 is [METHYLTHIO]ACETATE (CCD ID: MTG) (formula: $C_3H_5O_2S$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
9	B	1	Total	C	O	S	0	0
			6	3	2	1		

- Molecule 10 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	D	1	Total 1	Zn 1	0	0

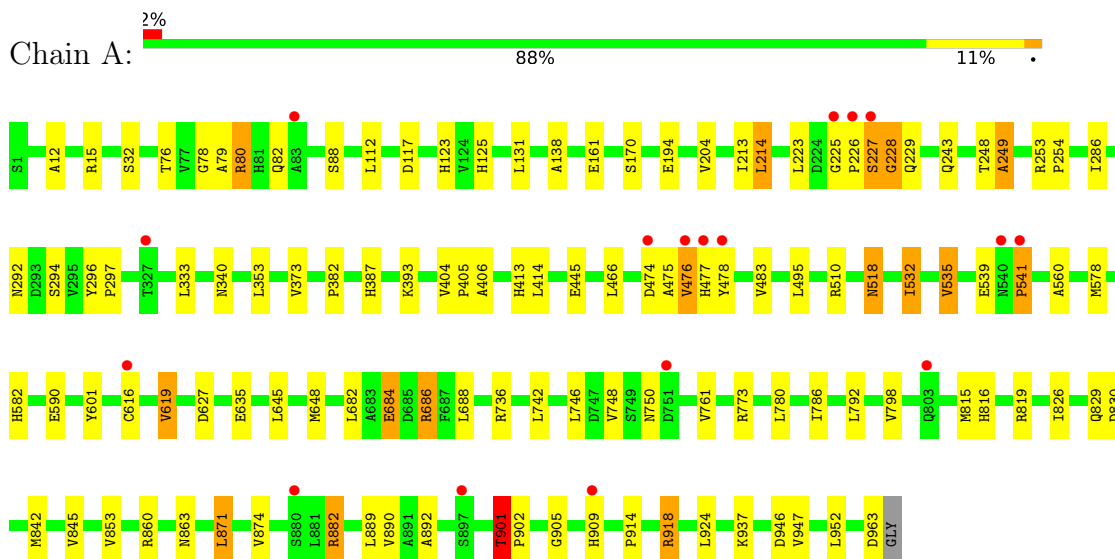
- Molecule 11 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
11	A	558	Total 558	O 558	0	0
11	B	184	Total 184	O 184	0	0
11	C	117	Total 117	O 117	0	0
11	D	65	Total 65	O 65	0	0

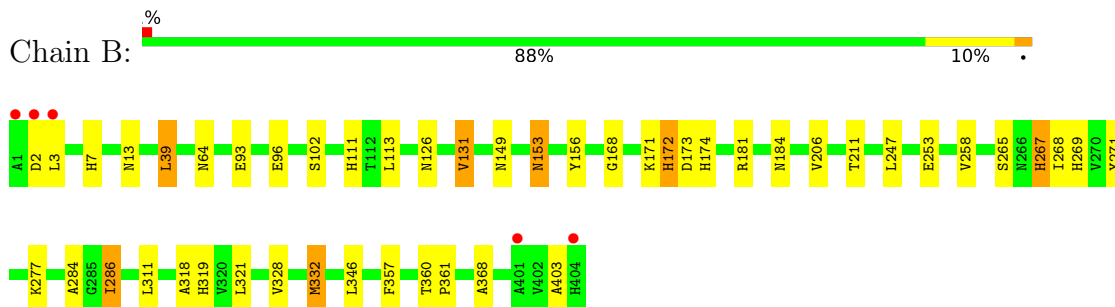
3 Residue-property plots [i](#)

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.

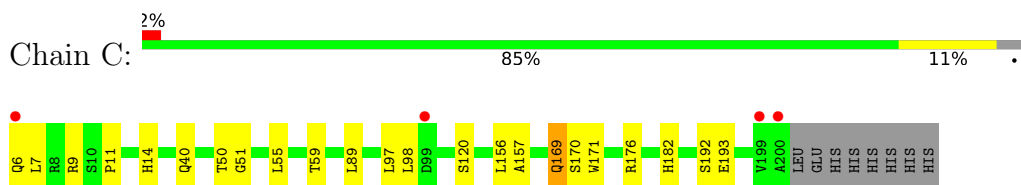
- Molecule 1: Subunit alpha of sarcosine oxidase



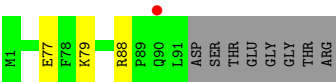
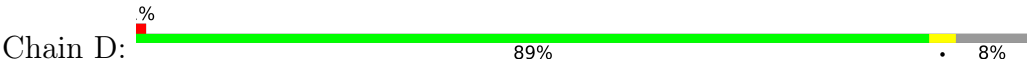
- Molecule 2: Subunit beta of sarcosine oxidase



- Molecule 3: Subunit gamma of sarcosine oxidase



- Molecule 4: Subunit delta of sarcosine oxidase



4 Data and refinement statistics

Property	Value	Source
Space group	P 65 2 2	Depositor
Cell constants a, b, c, α , β , γ	198.95Å 198.95Å 196.76Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	39.53 – 2.20 39.53 – 2.20	Depositor EDS
% Data completeness (in resolution range)	100.0 (39.53-2.20) 100.0 (39.53-2.20)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	0.08	Depositor
$\langle I/\sigma(I) \rangle$ ¹	6.22 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.170 , 0.205 0.170 , 0.206	Depositor DCC
R_{free} test set	5804 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	26.8	Xtriage
Anisotropy	0.072	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 38.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	13623	wwPDB-VP
Average B, all atoms (Å ²)	27.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.19% 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: ZN, SO4, NAD, MTG, FMN, 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	1.00	3/7361 (0.0%)	0.97	12/10017 (0.1%)
2	B	0.99	1/3189 (0.0%)	0.98	1/4340 (0.0%)
3	C	1.10	0/1461	0.98	0/1998
4	D	0.88	0/772	0.95	2/1040 (0.2%)
All	All	1.00	4/12783 (0.0%)	0.97	15/17395 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
2	B	0	1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	227	SER	CA-C	5.87	1.60	1.52
1	A	619	VAL	CA-CB	5.71	1.61	1.54
1	A	249	ALA	CA-CB	-5.49	1.44	1.53
2	B	206	VAL	CA-CB	5.07	1.61	1.54

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	225	GLY	CA-C-N	-6.44	113.03	119.99
1	A	225	GLY	C-N-CA	-6.44	113.03	119.99
1	A	228	GLY	N-CA-C	6.14	127.73	113.18
1	A	483	VAL	N-CA-C	-6.06	106.99	111.90
1	A	901	THR	CA-C-N	6.02	125.96	119.76

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	901	THR	C-N-CA	6.02	125.96	119.76
2	B	318	ALA	N-CA-C	-5.86	102.24	110.50
1	A	214	LEU	CA-CB-CG	-5.38	97.46	116.30
1	A	117	ASP	CA-C-N	-5.38	114.38	120.89
1	A	117	ASP	C-N-CA	-5.38	114.38	120.89
1	A	12	ALA	CA-C-N	-5.36	113.03	122.09
1	A	12	ALA	C-N-CA	-5.36	113.03	122.09
1	A	138	ALA	N-CA-C	5.35	116.80	111.07
4	D	88	ARG	CA-C-N	-5.11	115.30	120.31
4	D	88	ARG	C-N-CA	-5.11	115.30	120.31

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	B	268	ILE	Peptide

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	7229	0	7104	103	0
2	B	3108	0	3035	44	0
3	C	1433	0	1434	14	0
4	D	749	0	706	1	0
5	A	44	0	26	4	0
6	A	25	0	0	0	0
6	B	10	0	0	0	0
6	C	5	0	0	0	0
6	D	5	0	0	0	0
7	B	53	0	31	3	0
8	B	31	0	19	11	0
9	B	6	0	5	1	0
10	D	1	0	0	0	0
11	A	558	0	0	12	0
11	B	184	0	0	6	0
11	C	117	0	0	2	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
11	D	65	0	0	0	0
All	All	13623	0	12360	159	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 6.

All (159) 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)
2:B:172:HIS:NE2	8:B:406:FMN:C8M	1.79	1.44
2:B:172:HIS:NE2	8:B:406:FMN:HM82	1.01	1.30
1:A:829:GLN:HB2	1:A:909:HIS:HE1	1.10	1.17
1:A:829:GLN:HB2	1:A:909:HIS:CE1	1.87	1.10
1:A:882:ARG:HG2	1:A:882:ARG:HH11	1.14	1.07
2:B:172:HIS:CE1	8:B:406:FMN:HM82	1.90	1.06
1:A:829:GLN:OE1	1:A:909:HIS:NE2	1.88	1.04
3:C:169:GLN:NE2	3:C:171:TRP:HE1	1.61	0.97
3:C:169:GLN:HE21	3:C:171:TRP:HE1	1.03	0.96
1:A:15:ARG:HD2	1:A:161:GLU:OE2	1.74	0.88
1:A:829:GLN:CB	1:A:909:HIS:CE1	2.57	0.87
1:A:249:ALA:HB1	11:A:997:HOH:O	1.75	0.86
1:A:226:PRO:HB2	11:A:1211:HOH:O	1.75	0.85
1:A:15:ARG:CD	1:A:161:GLU:OE2	2.28	0.82
1:A:918:ARG:HH11	1:A:918:ARG:HG3	1.46	0.80
2:B:149:ASN:HD21	2:B:153:ASN:HD21	1.30	0.79
1:A:510:ARG:HH21	8:B:406:FMN:C5'	1.97	0.78
2:B:93:GLU:HG2	11:B:658:HOH:O	1.84	0.76
1:A:510:ARG:NH2	8:B:406:FMN:H5'2	2.00	0.76
1:A:475:ALA:O	1:A:477:HIS:N	2.21	0.74
2:B:286:ILE:HD11	2:B:328:VAL:HG21	1.70	0.74
1:A:892:ALA:HA	1:A:937:LYS:HD2	1.70	0.73
2:B:269:HIS:CE1	2:B:403:ALA:H	2.06	0.73
1:A:815:MET:HE2	1:A:816:HIS:HD2	1.54	0.72
1:A:882:ARG:HG2	1:A:882:ARG:NH1	1.91	0.71
2:B:172:HIS:NE2	8:B:406:FMN:HM81	1.98	0.70
1:A:474:ASP:HB3	1:A:477:HIS:CD2	2.27	0.69
1:A:292:ASN:HD22	1:A:294:SER:H	1.41	0.67
2:B:172:HIS:HD1	2:B:173:ASP:H	1.42	0.66
1:A:860:ARG:HH21	1:A:863:ASN:HD21	1.45	0.64
1:A:510:ARG:HH21	8:B:406:FMN:H5'2	1.57	0.64
1:A:82:GLN:HG2	11:A:1117:HOH:O	1.97	0.63

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:750:ASN:ND2	1:A:773:ARG:HH12	1.96	0.63
2:B:13:ASN:ND2	2:B:184:ASN:HD21	1.97	0.63
3:C:157:ALA:O	3:C:182:HIS:HE1	1.82	0.63
1:A:475:ALA:C	1:A:477:HIS:N	2.58	0.61
2:B:269:HIS:HE1	2:B:403:ALA:H	1.46	0.61
1:A:15:ARG:HD3	1:A:161:GLU:OE2	2.01	0.61
1:A:819:ARG:HH22	1:A:909:HIS:CG	2.18	0.61
1:A:901:THR:CG2	11:A:1137:HOH:O	2.48	0.61
1:A:125:HIS:HD2	11:A:1189:HOH:O	1.83	0.60
11:A:1272:HOH:O	3:C:182:HIS:HD2	1.83	0.60
1:A:243:GLN:OE1	1:A:413:HIS:HE1	1.84	0.60
1:A:249:ALA:HB2	5:A:965:NAD:PA	2.41	0.60
1:A:292:ASN:ND2	1:A:294:SER:H	1.99	0.60
1:A:648:MET:HA	1:A:648:MET:HE2	1.83	0.60
1:A:842:MET:O	1:A:845:VAL:HG12	2.01	0.60
1:A:510:ARG:NH2	8:B:406:FMN:C5'	2.63	0.60
2:B:172:HIS:HD1	2:B:173:ASP:N	2.01	0.59
1:A:826:ILE:CG2	1:A:829:GLN:HG3	2.32	0.59
1:A:475:ALA:C	1:A:477:HIS:H	2.10	0.59
1:A:750:ASN:HD22	1:A:773:ARG:HH12	1.50	0.58
1:A:249:ALA:HB2	5:A:965:NAD:O3	2.03	0.58
1:A:249:ALA:CB	5:A:965:NAD:O2A	2.52	0.58
1:A:510:ARG:HH21	8:B:406:FMN:H5'1	1.69	0.58
1:A:937:LYS:NZ	1:A:946:ASP:OD2	2.36	0.57
2:B:153:ASN:H	2:B:153:ASN:HD22	1.52	0.57
2:B:332:MET:HA	2:B:332:MET:HE2	1.87	0.57
1:A:736:ARG:NH2	1:A:963:ASP:O	2.28	0.57
1:A:474:ASP:HB3	1:A:477:HIS:HD2	1.68	0.56
2:B:172:HIS:CD2	8:B:406:FMN:C8M	2.80	0.56
1:A:249:ALA:HB2	5:A:965:NAD:O2A	2.06	0.56
1:A:223:LEU:HD12	1:A:226:PRO:HB3	1.89	0.55
2:B:2:ASP:HA	11:B:656:HOH:O	2.05	0.55
3:C:169:GLN:HE21	3:C:171:TRP:NE1	1.87	0.55
1:A:340:ASN:HB3	1:A:353:LEU:HD22	1.89	0.55
1:A:736:ARG:HD3	1:A:748:VAL:O	2.05	0.55
2:B:111:HIS:HD2	2:B:156:TYR:O	1.90	0.55
1:A:815:MET:CE	1:A:816:HIS:HD2	2.19	0.55
2:B:149:ASN:HD21	2:B:153:ASN:ND2	2.01	0.55
1:A:582:HIS:HE1	1:A:627:ASP:OD2	1.89	0.55
1:A:871:LEU:HD13	1:A:952:LEU:HD11	1.89	0.55
1:A:819:ARG:HD2	1:A:819:ARG:C	2.31	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:80:ARG:CG	1:A:80:ARG:HH11	2.21	0.54
2:B:360:THR:HB	2:B:361:PRO:HD3	1.89	0.54
2:B:64:ASN:HA	7:B:405:FAD:C6	2.38	0.54
3:C:176:ARG:HD3	11:C:398:HOH:O	2.08	0.53
1:A:815:MET:HE1	1:A:826:ILE:HD11	1.90	0.53
2:B:13:ASN:HD22	2:B:184:ASN:HD21	1.55	0.52
2:B:7:HIS:HE1	11:B:462:HOH:O	1.92	0.52
1:A:539:GLU:O	1:A:541:PRO:HD3	2.09	0.52
1:A:477:HIS:O	1:A:478:TYR:CD2	2.62	0.52
1:A:742:LEU:HD21	1:A:798:VAL:HG22	1.92	0.52
1:A:532:ILE:HD13	1:A:532:ILE:N	2.26	0.50
1:A:495:LEU:HD21	1:A:535:VAL:HG22	1.94	0.49
1:A:826:ILE:HG22	1:A:829:GLN:HG3	1.94	0.49
1:A:382:PRO:HG2	1:A:404:VAL:HG12	1.95	0.49
3:C:169:GLN:NE2	3:C:171:TRP:NE1	2.45	0.49
2:B:265:SER:O	2:B:269:HIS:HD2	1.95	0.49
2:B:39:LEU:HD13	2:B:368:ALA:HA	1.94	0.49
2:B:126:ASN:HB3	2:B:131:VAL:HG22	1.95	0.49
1:A:125:HIS:CE1	11:A:1513:HOH:O	2.66	0.48
2:B:265:SER:O	2:B:269:HIS:HA	2.13	0.48
3:C:11:PRO:HG2	3:C:120:SER:HB3	1.95	0.48
3:C:40:GLN:HA	3:C:89:LEU:O	2.12	0.48
1:A:78:GLY:O	1:A:79:ALA:C	2.55	0.48
1:A:248:THR:O	1:A:249:ALA:HB3	2.14	0.48
1:A:477:HIS:O	1:A:478:TYR:CG	2.67	0.48
1:A:901:THR:HG23	11:A:1137:HOH:O	2.13	0.48
3:C:51:GLY:HA3	11:C:213:HOH:O	2.13	0.48
1:A:905:GLY:HA3	1:A:924:LEU:O	2.14	0.47
1:A:918:ARG:HH11	1:A:918:ARG:CG	2.21	0.47
2:B:172:HIS:NE2	8:B:406:FMN:C8	2.72	0.47
1:A:582:HIS:CD2	1:A:601:TYR:OH	2.68	0.47
1:A:635:GLU:HG2	1:A:688:LEU:HD13	1.96	0.47
1:A:901:THR:HG22	11:A:1137:HOH:O	2.12	0.47
1:A:387:HIS:HD2	11:A:966:HOH:O	1.96	0.47
1:A:590:GLU:OE1	2:B:113:LEU:HD12	2.15	0.47
2:B:271:TYR:CZ	9:B:801:MTG:H43	2.49	0.47
1:A:736:ARG:HG2	1:A:748:VAL:CG2	2.45	0.47
2:B:102:SER:O	2:B:168:GLY:HA3	2.15	0.47
2:B:181:ARG:HD2	11:B:418:HOH:O	2.16	0.46
1:A:123:HIS:HE1	1:A:560:ALA:O	1.97	0.46
2:B:247:LEU:HD13	2:B:286:ILE:HD12	1.97	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:80:ARG:CG	1:A:80:ARG:NH1	2.78	0.46
1:A:475:ALA:O	1:A:476:VAL:C	2.57	0.46
3:C:6:GLN:O	3:C:7:LEU:HB2	2.16	0.46
1:A:204:VAL:HG13	1:A:213:ILE:HG23	1.97	0.46
1:A:901:THR:HA	1:A:902:PRO:HD3	1.81	0.46
1:A:648:MET:HE1	1:A:853:VAL:HG21	1.98	0.45
2:B:153:ASN:HD22	2:B:153:ASN:N	2.13	0.45
3:C:55:LEU:O	3:C:59:THR:HG23	2.17	0.45
2:B:277:LYS:NZ	11:B:732:HOH:O	2.16	0.45
3:C:9:ARG:HH21	3:C:14:HIS:HB3	1.80	0.45
1:A:125:HIS:HE1	11:A:1513:HOH:O	2.00	0.44
1:A:387:HIS:HE1	1:A:393:LYS:O	2.00	0.44
1:A:131:LEU:HD23	1:A:213:ILE:HG13	2.00	0.44
1:A:296:TYR:N	1:A:297:PRO:CD	2.80	0.44
3:C:192:SER:O	3:C:193:GLU:C	2.59	0.44
1:A:736:ARG:HB2	1:A:780:LEU:HD21	2.00	0.43
2:B:7:HIS:CE1	2:B:174:HIS:HE1	2.36	0.43
2:B:96:GLU:O	2:B:181:ARG:NH2	2.52	0.43
1:A:684:GLU:O	1:A:684:GLU:HG3	2.19	0.42
1:A:405:PRO:HB2	1:A:414:LEU:HD13	2.00	0.42
1:A:882:ARG:NH1	1:A:882:ARG:CG	2.69	0.42
2:B:267:HIS:HD2	11:B:587:HOH:O	2.02	0.42
1:A:82:GLN:CG	11:A:1117:HOH:O	2.62	0.42
4:D:77:GLU:OE2	4:D:79:LYS:NZ	2.52	0.42
1:A:616:CYS:HB2	1:A:914:PRO:HG2	2.01	0.42
1:A:830:ASP:OD1	1:A:909:HIS:ND1	2.53	0.42
2:B:111:HIS:CE1	2:B:265:SER:OG	2.73	0.42
2:B:171:LYS:HE2	2:B:174:HIS:CD2	2.54	0.42
1:A:80:ARG:NH1	1:A:80:ARG:HG3	2.35	0.41
1:A:76:THR:HA	1:A:88:SER:HA	2.01	0.41
1:A:286:ILE:HD12	1:A:373:VAL:HB	2.03	0.41
1:A:860:ARG:NH2	1:A:863:ASN:HD21	2.16	0.41
1:A:131:LEU:CD2	1:A:213:ILE:HG13	2.51	0.41
1:A:253:ARG:HB2	1:A:254:PRO:HD2	2.03	0.41
1:A:518:ASN:ND2	1:A:518:ASN:C	2.78	0.41
1:A:736:ARG:HG2	1:A:748:VAL:HG23	2.03	0.41
1:A:871:LEU:HD13	1:A:952:LEU:CD1	2.50	0.41
1:A:918:ARG:HG3	1:A:918:ARG:NH1	2.22	0.41
2:B:253:GLU:OE2	2:B:319:HIS:ND1	2.41	0.41
1:A:204:VAL:HG13	1:A:213:ILE:CG2	2.51	0.41
1:A:682:LEU:HD12	1:A:686:ARG:HD2	2.04	0.40

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:64:ASN:HA	7:B:405:FAD:C5X	2.52	0.40
2:B:357:PHE:HB3	7:B:405:FAD:C2	2.51	0.40
1:A:112:LEU:HD12	2:B:258:VAL:HG21	2.04	0.40
1:A:518:ASN:HA	2:B:321:LEU:HD11	2.02	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	961/964 (100%)	936 (97%)	21 (2%)	4 (0%)	30	34
2	B	402/404 (100%)	392 (98%)	9 (2%)	1 (0%)	43	51
3	C	193/203 (95%)	187 (97%)	6 (3%)	0	100	100
4	D	89/99 (90%)	88 (99%)	1 (1%)	0	100	100
All	All	1645/1670 (98%)	1603 (97%)	37 (2%)	5 (0%)	36	42

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	227	SER
1	A	476	VAL
1	A	228	GLY
1	A	406	ALA
2	B	284	ALA

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	747/747 (100%)	717 (96%)	30 (4%)	28	38
2	B	319/319 (100%)	308 (97%)	11 (3%)	32	44
3	C	143/151 (95%)	137 (96%)	6 (4%)	26	36
4	D	75/81 (93%)	75 (100%)	0	100	100
All	All	1284/1298 (99%)	1237 (96%)	47 (4%)	30	41

All (47) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	32	SER
1	A	80	ARG
1	A	170	SER
1	A	194	GLU
1	A	214	LEU
1	A	229	GLN
1	A	333	LEU
1	A	445	GLU
1	A	466	LEU
1	A	518	ASN
1	A	532	ILE
1	A	535	VAL
1	A	541	PRO
1	A	578	MET
1	A	619	VAL
1	A	645	LEU
1	A	684	GLU
1	A	686	ARG
1	A	746	LEU
1	A	761	VAL
1	A	786	ILE
1	A	792	LEU
1	A	871	LEU
1	A	874	VAL
1	A	882	ARG
1	A	889	LEU
1	A	890	VAL
1	A	901	THR
1	A	918	ARG
1	A	947	VAL

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Mol	Chain	Res	Type
2	B	3	LEU
2	B	39	LEU
2	B	131	VAL
2	B	153	ASN
2	B	172	HIS
2	B	211	THR
2	B	267	HIS
2	B	286	ILE
2	B	311	LEU
2	B	332	MET
2	B	346	LEU
3	C	50	THR
3	C	97	LEU
3	C	98	LEU
3	C	156	LEU
3	C	169	GLN
3	C	170	SER

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (37) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	10	GLN
1	A	123	HIS
1	A	125	HIS
1	A	181	GLN
1	A	200	GLN
1	A	229	GLN
1	A	292	ASN
1	A	387	HIS
1	A	413	HIS
1	A	477	HIS
1	A	486	GLN
1	A	489	GLN
1	A	518	ASN
1	A	540	ASN
1	A	582	HIS
1	A	750	ASN
1	A	803	GLN
1	A	816	HIS
1	A	863	ASN
1	A	912	ASN
2	B	7	HIS

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Mol	Chain	Res	Type
2	B	13	ASN
2	B	111	HIS
2	B	126	ASN
2	B	153	ASN
2	B	259	HIS
2	B	267	HIS
2	B	269	HIS
2	B	344	GLN
2	B	369	HIS
3	C	6	GLN
3	C	40	GLN
3	C	123	GLN
3	C	158	ASN
3	C	169	GLN
3	C	182	HIS
4	D	32	ASN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 14 ligands modelled in this entry, 1 is monoatomic - leaving 13 for Mogul analysis.

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
9	MTG	B	801	-	5,5,5	0.85	0	4,5,5	1.82	1 (25%)
6	SO4	C	2564	-	4,4,4	0.45	0	6,6,6	0.30	0
6	SO4	A	2559	-	4,4,4	0.24	0	6,6,6	0.12	0
6	SO4	D	2566	-	4,4,4	0.28	0	6,6,6	0.12	0
6	SO4	A	2571	-	4,4,4	0.29	0	6,6,6	0.45	0
6	SO4	B	2569	-	4,4,4	0.22	0	6,6,6	0.39	0
6	SO4	B	2568	-	4,4,4	0.28	0	6,6,6	0.29	0
6	SO4	A	2567	-	4,4,4	0.19	0	6,6,6	0.42	0
8	FMN	B	406	-	33,33,33	1.88	10 (30%)	48,50,50	2.19	14 (29%)
7	FAD	B	405	-	58,58,58	1.29	7 (12%)	85,89,89	1.68	19 (22%)
6	SO4	A	2563	-	4,4,4	0.27	0	6,6,6	0.30	0
6	SO4	A	2560	-	4,4,4	0.38	0	6,6,6	0.39	0
5	NAD	A	965	-	46,48,48	1.77	7 (15%)	64,73,73	1.75	13 (20%)

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
9	MTG	B	801	-	-	1/3/3/3	-
5	NAD	A	965	-	-	3/30/62/62	0/5/5/5
8	FMN	B	406	-	-	9/18/18/18	0/3/3/3
7	FAD	B	405	-	-	2/34/50/50	0/6/6/6

All (24) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	A	965	NAD	O7N-C7N	7.14	1.37	1.24
5	A	965	NAD	C2N-N1N	5.84	1.41	1.35
8	B	406	FMN	O5'-C5'	-5.09	1.25	1.44
7	B	405	FAD	C4X-N5	4.54	1.40	1.30
8	B	406	FMN	C4A-N5	4.18	1.39	1.30
8	B	406	FMN	C8M-C8	3.55	1.57	1.51
7	B	405	FAD	C10-N1	3.52	1.40	1.33
5	A	965	NAD	C5A-N7A	-3.32	1.33	1.39
8	B	406	FMN	C1'-C2'	2.69	1.56	1.52
7	B	405	FAD	PA-O3P	-2.52	1.56	1.59
7	B	405	FAD	O4'-C4'	2.49	1.48	1.43
8	B	406	FMN	C7M-C7	2.47	1.55	1.51
8	B	406	FMN	C10-N1	2.34	1.37	1.33

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
7	B	405	FAD	C5A-N7A	-2.33	1.34	1.39
7	B	405	FAD	C10-N10	2.31	1.42	1.37
8	B	406	FMN	C9A-C5A	-2.27	1.37	1.41
5	A	965	NAD	C6N-N1N	2.26	1.40	1.35
8	B	406	FMN	C4-N3	2.25	1.43	1.38
8	B	406	FMN	P-O3P	2.16	1.62	1.54
5	A	965	NAD	C4A-N9A	-2.14	1.33	1.37
8	B	406	FMN	C4A-C10	-2.12	1.38	1.44
5	A	965	NAD	PA-O3	2.07	1.61	1.59
5	A	965	NAD	PN-O3	2.04	1.61	1.59
7	B	405	FAD	C9-C8	2.02	1.42	1.39

All (47) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
8	B	406	FMN	C5'-C4'-C3'	-6.49	99.98	112.22
8	B	406	FMN	O4'-C4'-C5'	-6.38	95.92	109.99
7	B	405	FAD	C5A-C4A-N3A	-5.33	119.38	126.72
5	A	965	NAD	C5A-C4A-N3A	-4.85	120.04	126.72
8	B	406	FMN	O5'-P-O1P	4.76	119.29	106.44
7	B	405	FAD	N3A-C2A-N1A	-4.49	121.79	128.58
5	A	965	NAD	N3A-C2A-N1A	-4.48	121.80	128.58
7	B	405	FAD	N9A-C8A-N7A	-4.10	108.12	113.94
7	B	405	FAD	N3A-C4A-N9A	4.00	133.97	127.17
5	A	965	NAD	O4B-C1B-C2B	-3.91	98.26	106.62
5	A	965	NAD	N9A-C8A-N7A	-3.80	108.55	113.94
7	B	405	FAD	C4-N3-C2	-3.75	118.98	125.64
7	B	405	FAD	C5A-N7A-C8A	3.75	109.34	103.45
5	A	965	NAD	C4A-C5A-N7A	-3.64	106.42	110.58
5	A	965	NAD	C5A-N7A-C8A	3.57	109.06	103.45
7	B	405	FAD	C2A-N3A-C4A	3.43	120.20	111.83
5	A	965	NAD	C6N-N1N-C2N	-3.38	119.00	121.88
8	B	406	FMN	C4-N3-C2	-3.38	119.64	125.64
8	B	406	FMN	C9A-C5A-N5	-3.37	118.88	122.45
8	B	406	FMN	O4-C4-C4A	-3.30	117.83	126.53
5	A	965	NAD	O4B-C1B-N9A	-3.25	101.85	108.09
7	B	405	FAD	C4A-C5A-N7A	-3.24	106.88	110.58
5	A	965	NAD	C2A-N3A-C4A	3.23	119.71	111.83
7	B	405	FAD	C4A-N9A-C8A	3.09	108.99	105.74
8	B	406	FMN	C5A-C9A-N10	2.99	120.67	117.97
7	B	405	FAD	C10-C4X-N5	-2.94	118.81	124.81
9	B	801	MTG	O5-C1-C2	-2.60	115.81	122.85

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	965	NAD	N3A-C4A-N9A	2.57	131.53	127.17
7	B	405	FAD	C4X-C4-N3	2.54	119.73	113.25
8	B	406	FMN	C9-C9A-N10	-2.50	118.50	121.85
7	B	405	FAD	C9A-C5X-N5	-2.47	119.83	122.45
7	B	405	FAD	C5'-C4'-C3'	-2.46	107.58	112.22
7	B	405	FAD	C5X-N5-C4X	2.40	121.97	118.09
5	A	965	NAD	O7N-C7N-C3N	2.38	122.51	119.60
8	B	406	FMN	C4'-C3'-C2'	2.36	117.50	113.57
8	B	406	FMN	C4A-C4-N3	2.35	119.24	113.25
7	B	405	FAD	O4-C4-C4X	-2.32	120.40	126.53
7	B	405	FAD	C4B-O4B-C1B	-2.31	104.36	109.47
8	B	406	FMN	C8M-C8-C9	-2.31	115.50	119.57
8	B	406	FMN	O2'-C2'-C3'	-2.27	103.93	109.25
7	B	405	FAD	C4-C4X-C10	2.26	120.81	116.93
5	A	965	NAD	C2A-N1A-C6A	2.26	122.44	118.73
8	B	406	FMN	O3'-C3'-C2'	2.21	113.96	108.93
5	A	965	NAD	C5A-C4A-N9A	2.20	108.21	105.81
8	B	406	FMN	O2-C2-N1	-2.20	118.15	121.80
7	B	405	FAD	C4X-C10-N10	2.19	119.61	116.48
7	B	405	FAD	C6-C5X-C9A	2.05	121.87	119.05

There are no chirality outliers.

All (15) torsion outliers are listed below:

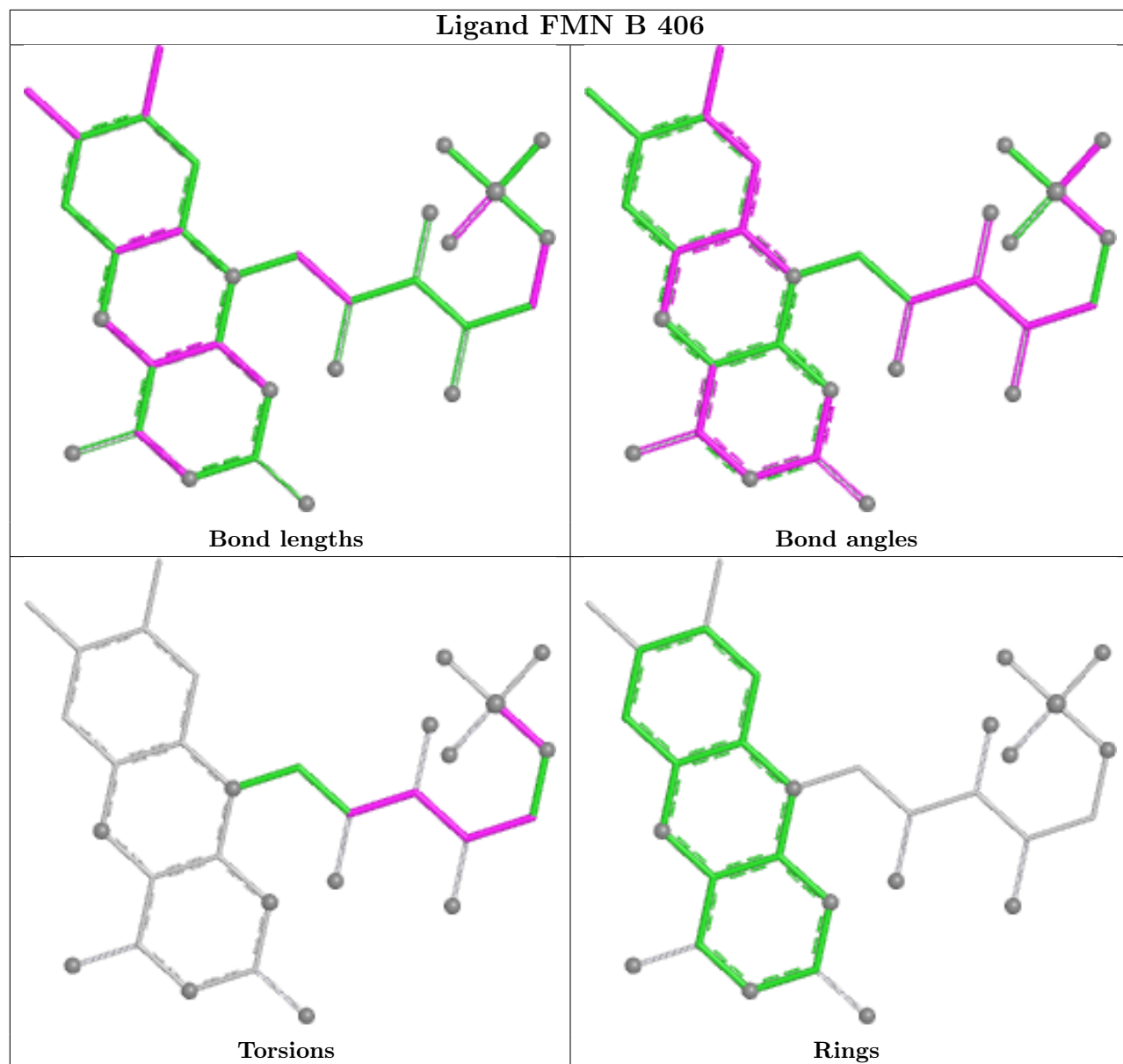
Mol	Chain	Res	Type	Atoms
8	B	406	FMN	C1'-C2'-C3'-C4'
8	B	406	FMN	O3'-C3'-C4'-C5'
8	B	406	FMN	C3'-C4'-C5'-O5'
8	B	406	FMN	C5'-O5'-P-O3P
8	B	406	FMN	C2'-C3'-C4'-C5'
8	B	406	FMN	C2'-C3'-C4'-O4'
8	B	406	FMN	O2'-C2'-C3'-C4'
7	B	405	FAD	C4'-C5'-O5'-P
8	B	406	FMN	O4'-C4'-C5'-O5'
5	A	965	NAD	C5D-O5D-PN-O1N
7	B	405	FAD	C5'-O5'-P-O1P
5	A	965	NAD	PA-O3-PN-O5D
8	B	406	FMN	C5'-O5'-P-O2P
9	B	801	MTG	O6-C1-C2-S3
5	A	965	NAD	O4D-C4D-C5D-O5D

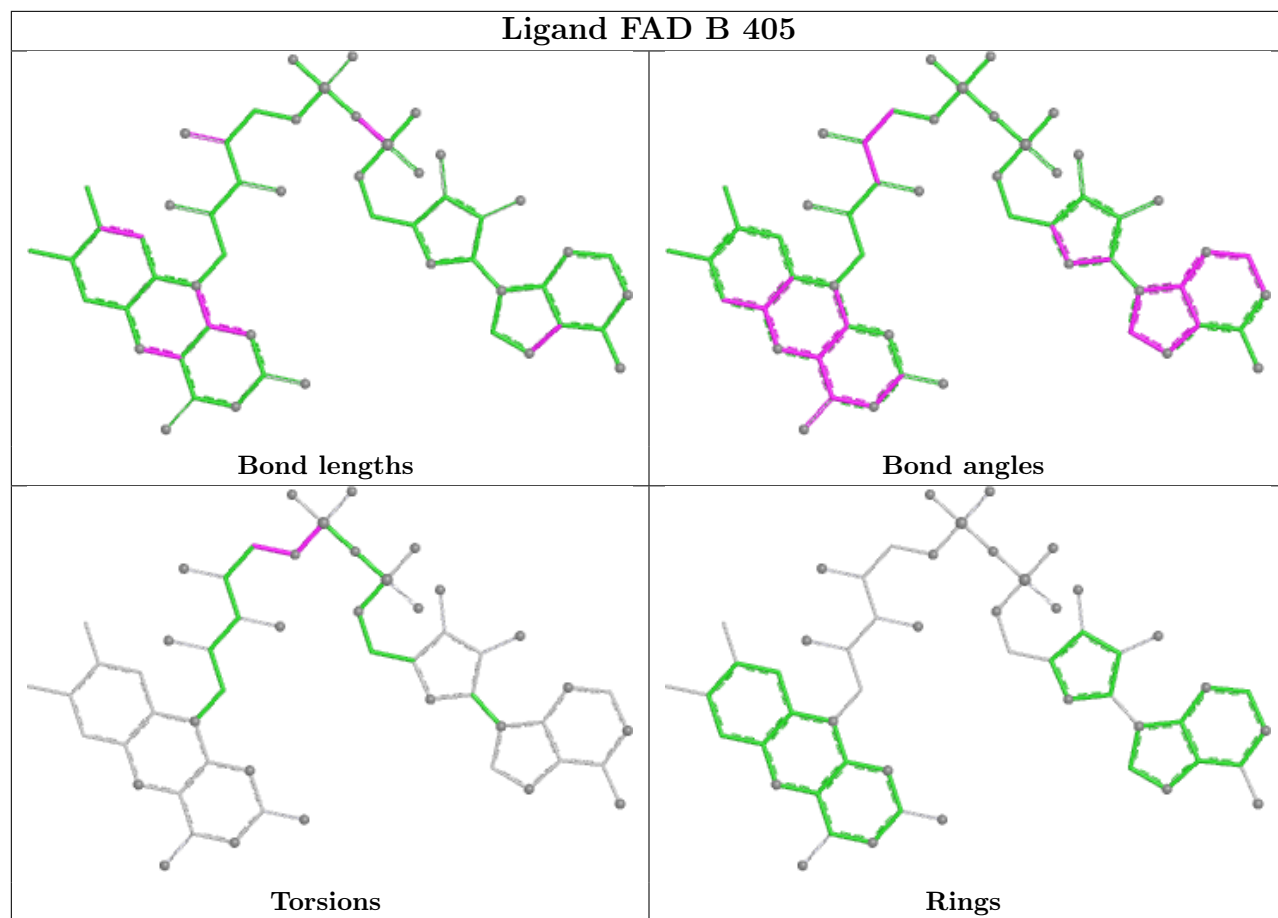
There are no ring outliers.

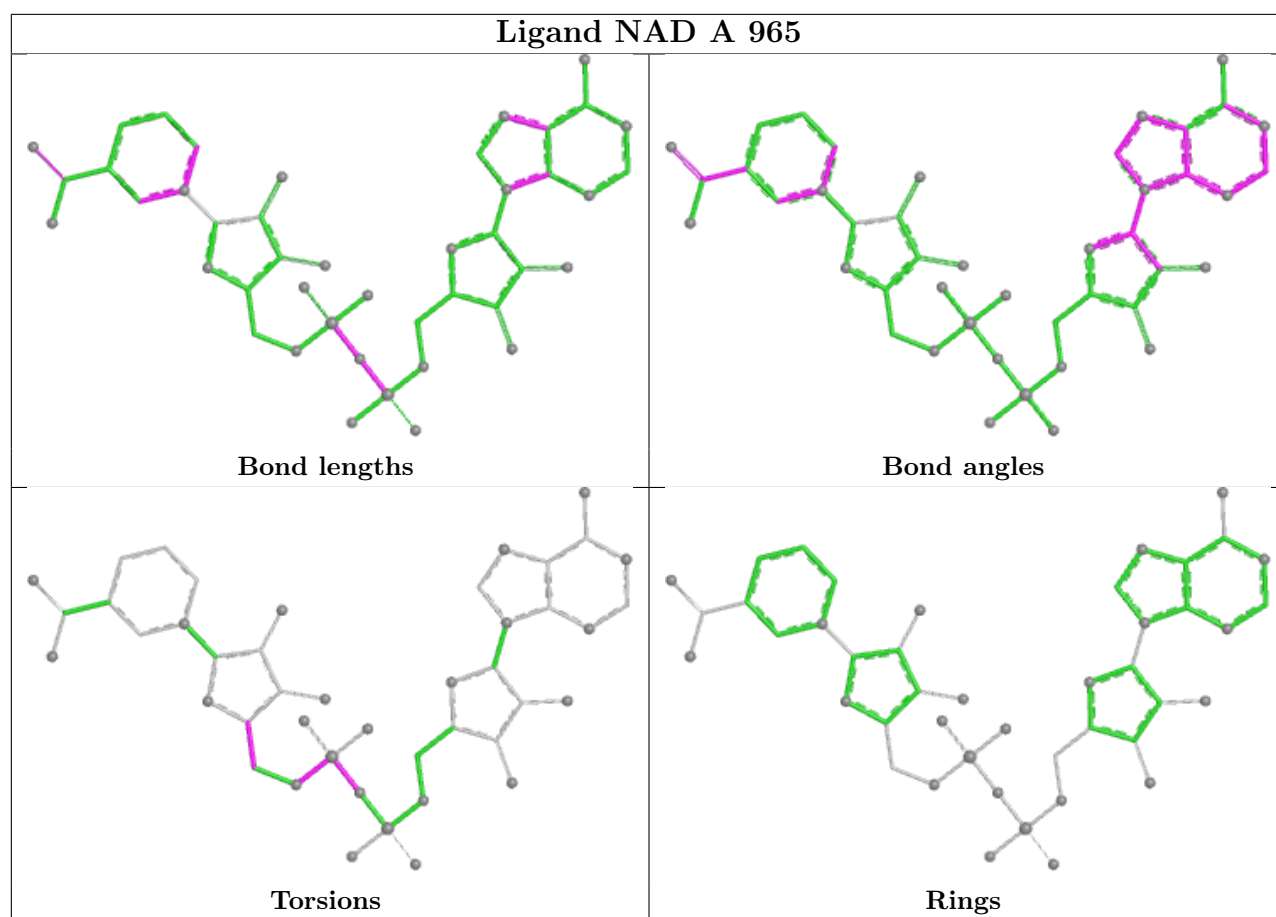
4 monomers are involved in 19 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
9	B	801	MTG	1	0
8	B	406	FMN	11	0
7	B	405	FAD	3	0
5	A	965	NAD	4	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	963/964 (99%)	-0.34	17 (1%) 67 64	13, 26, 43, 61	0
2	B	404/404 (100%)	-0.36	5 (1%) 76 74	14, 26, 41, 64	0
3	C	195/203 (96%)	-0.33	4 (2%) 63 60	16, 24, 41, 55	0
4	D	91/99 (91%)	-0.47	1 (1%) 78 76	18, 23, 42, 52	0
All	All	1653/1670 (98%)	-0.35	27 (1%) 70 67	13, 25, 43, 64	0

All (27) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	C	200	ALA	5.6
2	B	1	ALA	4.9
1	A	226	PRO	4.7
1	A	477	HIS	4.6
1	A	909	HIS	4.2
1	A	327	THR	4.0
1	A	225	GLY	3.8
2	B	2	ASP	3.7
1	A	227	SER	3.5
2	B	3	LEU	3.2
3	C	6	GLN	3.2
1	A	478	TYR	3.0
2	B	404	HIS	2.8
4	D	90	GLN	2.6
1	A	476	VAL	2.4
1	A	540	ASN	2.4
1	A	616	CYS	2.3
1	A	474	ASP	2.3
1	A	803	GLN	2.2
1	A	897	SER	2.2
3	C	199	VAL	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	541	PRO	2.2
2	B	401	ALA	2.1
1	A	751	ASP	2.1
3	C	99	ASP	2.1
1	A	880	SER	2.0
1	A	83	ALA	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.

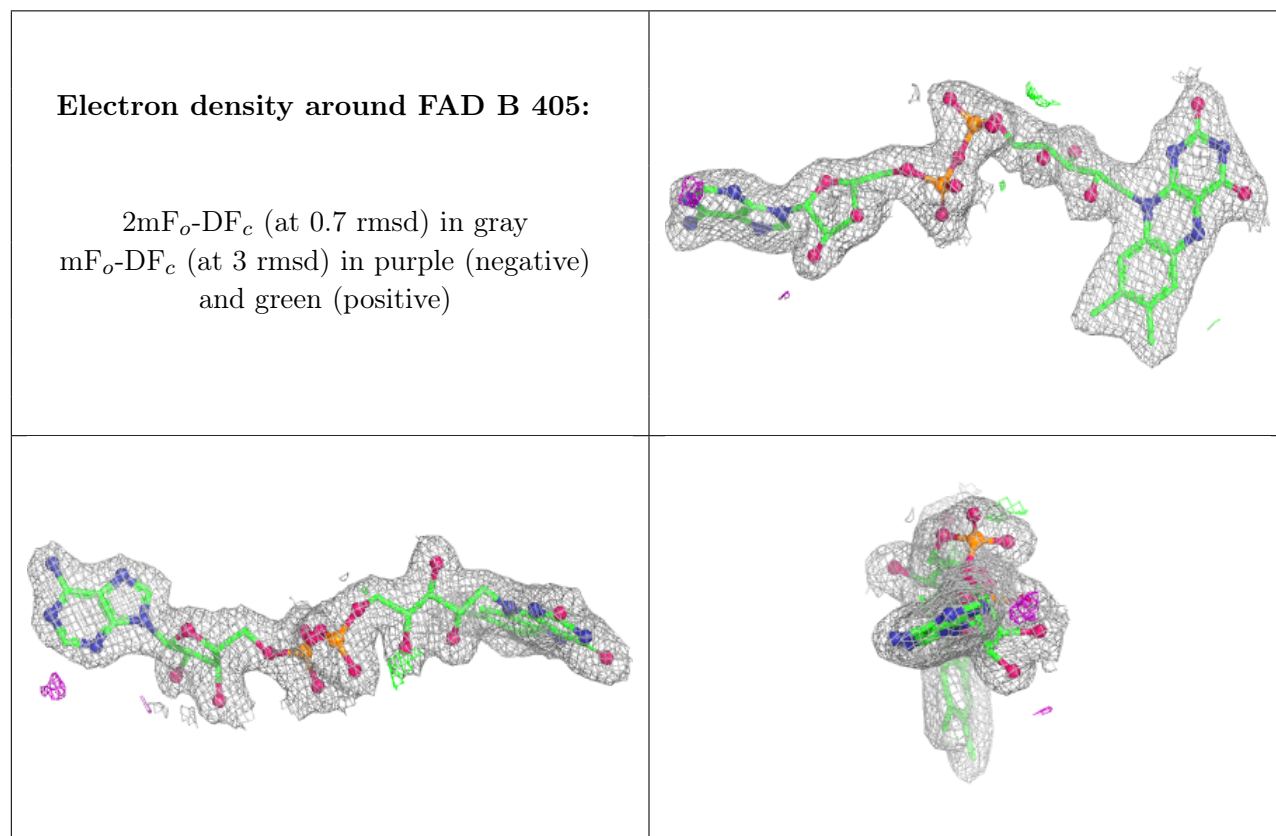
6.4 Ligands [i](#)

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, 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
6	SO4	A	2563	5/5	0.79	0.12	84,84,84,85	0
6	SO4	D	2566	5/5	0.82	0.09	89,89,90,90	0
6	SO4	A	2571	5/5	0.90	0.09	70,70,70,71	0
9	MTG	B	801	6/6	0.91	0.13	48,49,50,54	0
6	SO4	B	2568	5/5	0.93	0.08	64,65,67,67	0
6	SO4	B	2569	5/5	0.93	0.12	59,60,61,61	0
6	SO4	A	2559	5/5	0.95	0.11	54,56,57,57	0
6	SO4	A	2560	5/5	0.95	0.09	49,50,52,52	0
7	FAD	B	405	53/53	0.97	0.06	19,24,27,28	0
6	SO4	C	2564	5/5	0.97	0.13	35,35,38,38	0
8	FMN	B	406	31/31	0.98	0.05	12,15,21,23	0
6	SO4	A	2567	5/5	0.98	0.05	33,34,38,40	0
5	NAD	A	965	44/44	0.99	0.04	11,16,21,26	0
10	ZN	D	100	1/1	1.00	0.02	21,21,21,21	0

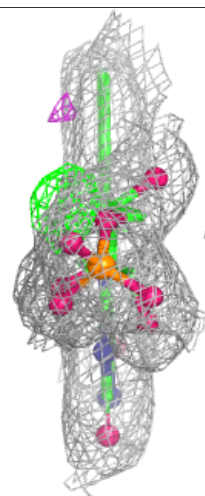
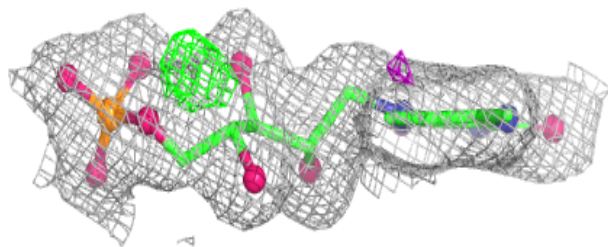
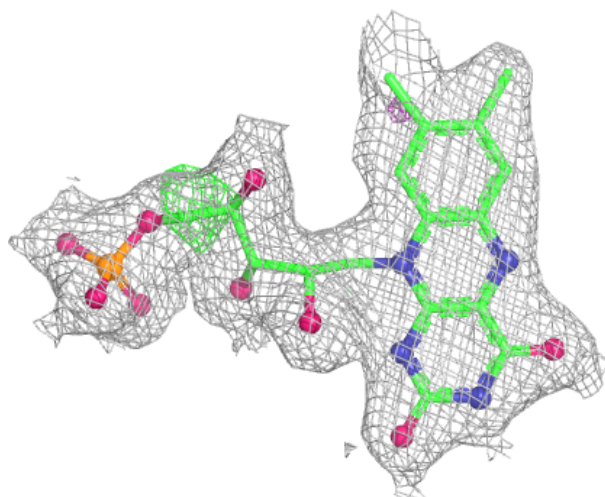
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers

as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.



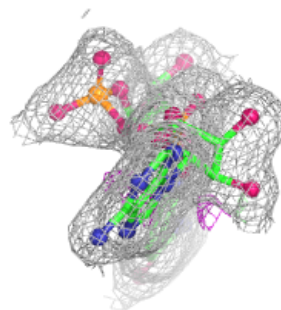
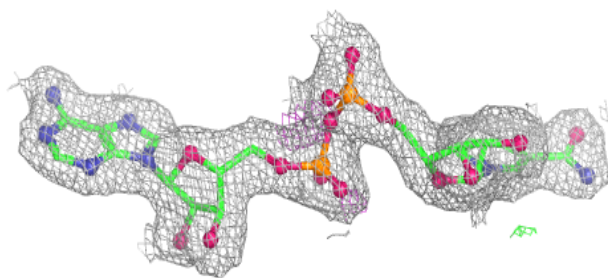
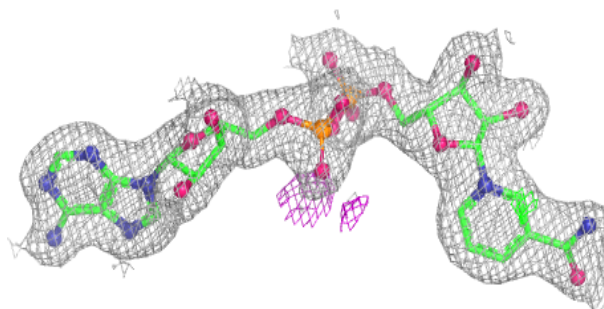
Electron density around FMN B 406:

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



Electron density around NAD A 965:

$2mF_o - DF_c$ (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.