Full wwPDB X-ray Structure Validation Report (i)

Apr 14, 2026 – 01:24 pm BST

PDB ID	:	9RUW / pdb_00009ruw
Title	:	Nicotine Glucoside Synthase (BBL) in complex with FAD
Authors	:	Schwabe, B.T.W.; Lichman, B.R.; Grogan, G.
Deposited on	:	2025-07-05
Resolution	:	2.55 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 (i) symbol.

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

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

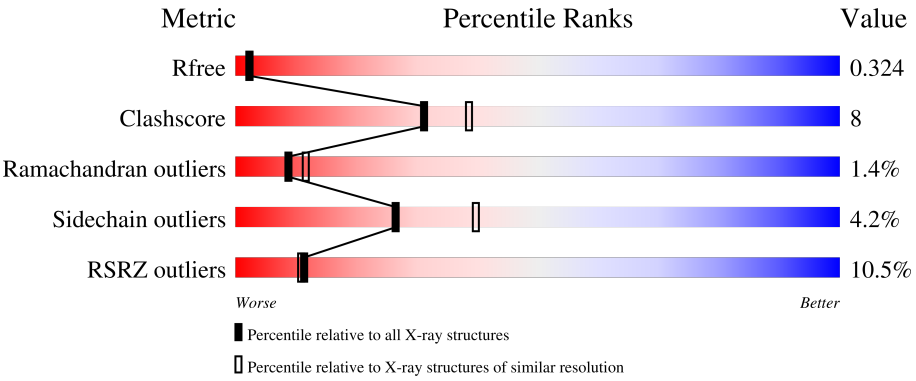
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal 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 (i)

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

The reported resolution of this entry is 2.55 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	1091 (2.54-2.54)
Clashscore	190562	1120 (2.54-2.54)
Ramachandran outliers	187476	1106 (2.54-2.54)
Sidechain outliers	187428	1106 (2.54-2.54)
RSRZ outliers	180081	1091 (2.54-2.54)

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

Mol	Chain	Length	Quality of chain
1	A	560	9% 69% 18% • 11%
1	B	560	9% 72% 15% • 11%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 7898 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.

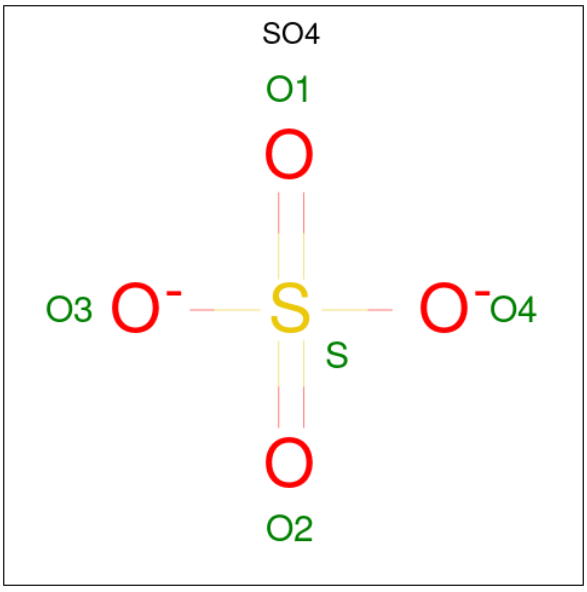
- Molecule 1 is a protein called Berberine bridge enzyme-like A.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	498	Total	C	N	O	S	0	1	0
			3867	2497	629	719	22			
1	B	497	Total	C	N	O	S	0	0	0
			3862	2496	630	714	22			

There are 4 discrepancies between the modelled and reference sequences:

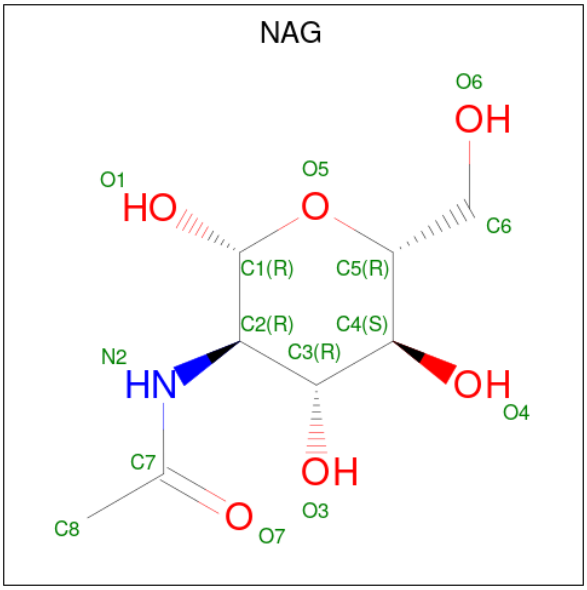
Chain	Residue	Modelled	Actual	Comment	Reference
A	0	MET	-	initiating methionine	UNP F1T160
A	1	GLY	-	expression tag	UNP F1T160
B	0	MET	-	initiating methionine	UNP F1T160
B	1	GLY	-	expression tag	UNP F1T160

- Molecule 2 is SULFATE ION (CCD ID: SO4) (formula: O_4S).



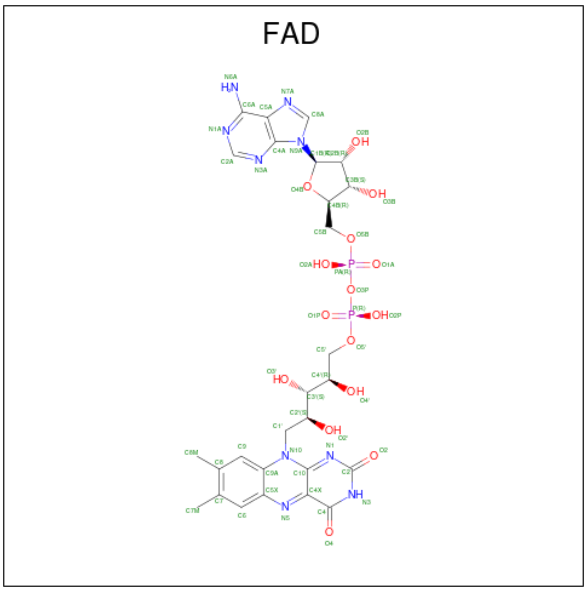
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total O S 5 4 1	0	0

- Molecule 3 is 2-acetamido-2-deoxy-beta-D-glucopyranose (CCD ID: NAG) (formula: $C_8H_{15}NO_6$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C N O 14 8 1 5	0	0
3	A	1	Total C N O 14 8 1 5	0	0

- Molecule 4 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$) (labeled as "Ligand of Interest" by depositor).



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

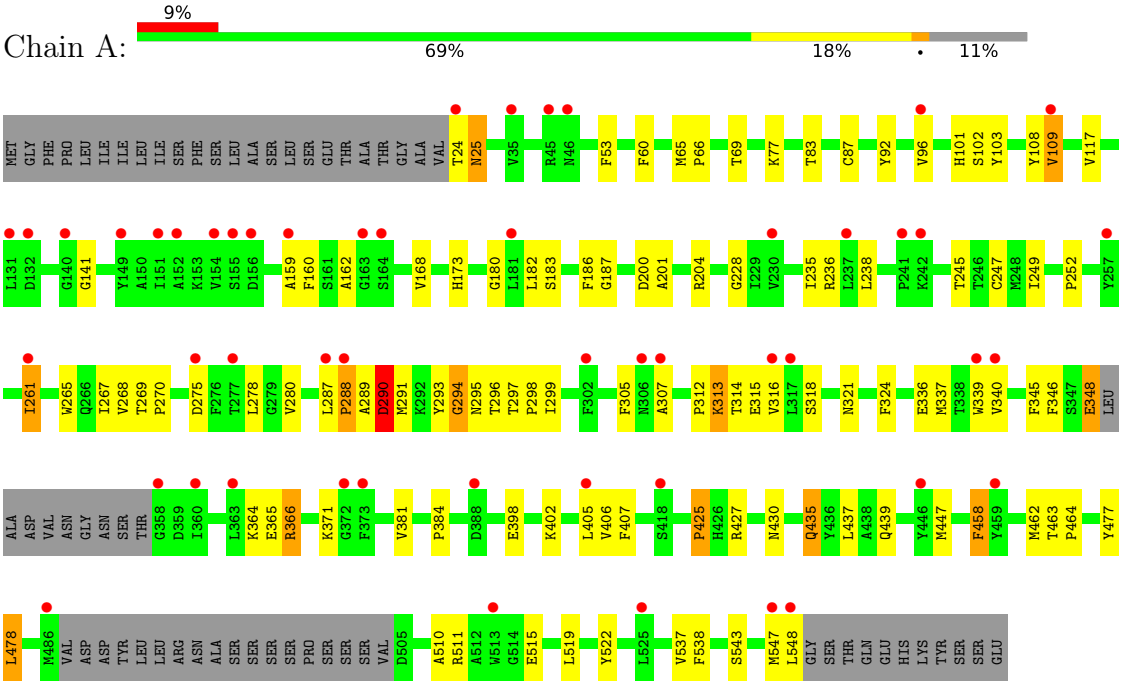
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	17	Total	O	0	0
			17	17		
5	B	13	Total	O	0	0
			13	13		

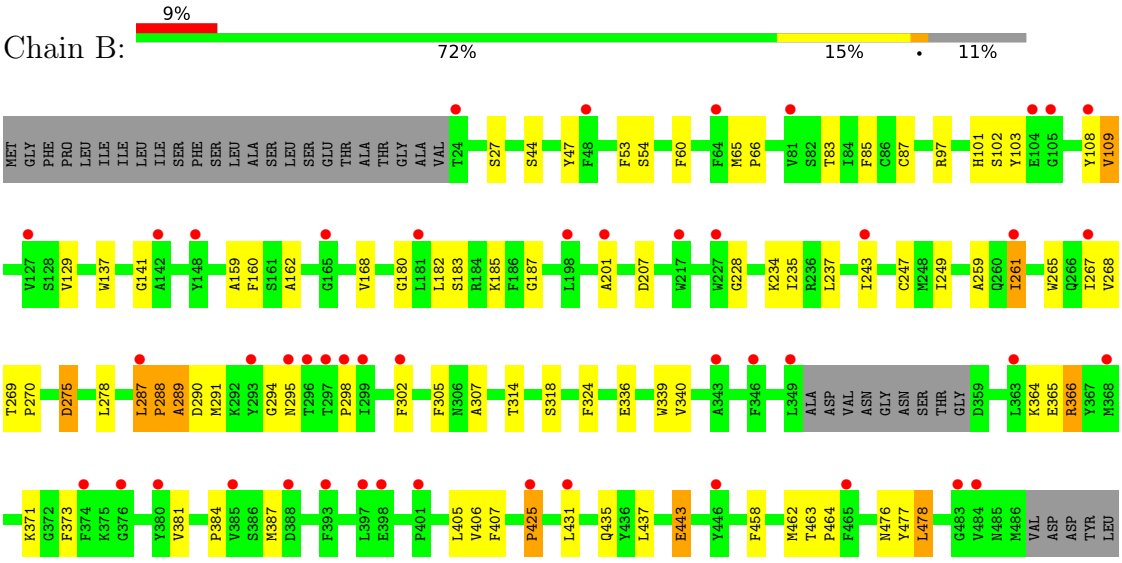
3 Residue-property plots (i)

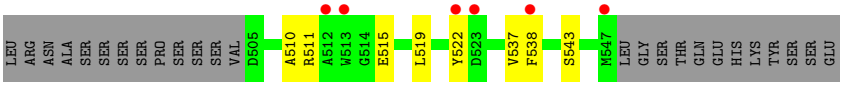
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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: Berberine bridge enzyme-like A



• Molecule 1: Berberine bridge enzyme-like A




LEU
ARG
ASN
ALA
SER
SER
SER
SER
PRO
SER
SER
SER
VAL
D505
A510
R511
A512
W513
G514
E515
L519
Y522
D523
V537
F538
S543
M547
LEU
GLY
SER
THR
GLN
GLU
HIS
LYS
TYR
SER
SER
GLU

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	81.62Å 111.73Å 146.28Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	73.25 – 2.55 73.25 – 2.55	Depositor EDS
% Data completeness (in resolution range)	100.0 (73.25-2.55) 100.0 (73.25-2.55)	Depositor EDS
R_{merge}	0.39	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.08 (at 2.55Å)	Xtriage
Refinement program	REFMAC 5.8.0430	Depositor
R, R_{free}	0.293 , 0.324 0.293 , 0.324	Depositor DCC
R_{free} test set	2179 reflections (4.91%)	wwPDB-VP
Wilson B-factor (Å^2)	37.2	Xtriage
Anisotropy	1.009	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 43.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.42$, $< L^2 > = 0.24$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.89	EDS
Total number of atoms	7898	wwPDB-VP
Average B, all atoms (Å^2)	48.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.79% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

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

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, FAD, NAG

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	0.50	0/3971	1.02	3/5397 (0.1%)
1	B	0.51	0/3964	1.03	3/5388 (0.1%)
All	All	0.51	0/7935	1.03	6/10785 (0.1%)

There are no bond length outliers.

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	314	THR	CA-CB-OG1	-6.36	100.06	109.60
1	B	207	ASP	CA-CB-CG	5.38	117.98	112.60
1	A	458	PHE	CA-CB-CG	5.24	119.04	113.80
1	A	435	GLN	N-CA-CB	-5.21	102.73	110.71
1	B	85	PHE	CA-CB-CG	5.19	118.99	113.80
1	A	69	THR	CA-CB-OG1	-5.03	102.05	109.60

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	3867	0	3687	73	0
1	B	3862	0	3704	55	0
2	A	5	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	28	0	26	0	0
4	A	53	0	31	6	0
4	B	53	0	31	4	0
5	A	17	0	0	1	0
5	B	13	0	0	0	0
All	All	7898	0	7479	124	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 8.

All (124) 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:267:ILE:HD11	1:B:267:ILE:HD11	1.56	0.86
1:B:101:HIS:ND1	4:B:601:FAD:C8M	2.51	0.73
1:B:101:HIS:ND1	4:B:601:FAD:HM83	2.06	0.70
1:A:287:LEU:O	1:A:289:ALA:N	2.31	0.63
1:B:287:LEU:N	1:B:288:PRO:HD2	2.14	0.63
1:A:288:PRO:O	1:A:289:ALA:HB3	2.00	0.61
1:A:406:VAL:HB	1:A:435:GLN:HB3	1.82	0.61
1:B:406:VAL:HB	1:B:435:GLN:HB3	1.84	0.60
1:B:65:MET:HE3	1:B:66:PRO:HD2	1.84	0.60
1:B:83:THR:O	1:B:87:CYS:SG	2.60	0.60
1:A:83:THR:O	1:A:87:CYS:SG	2.60	0.59
1:B:364:LYS:O	1:B:365:GLU:C	2.46	0.58
1:A:249:ILE:HB	1:A:305:PHE:HB2	1.87	0.57
1:A:101:HIS:ND1	4:A:604:FAD:C8M	2.68	0.57
1:A:384:PRO:HG3	1:B:384:PRO:HG3	1.86	0.57
1:A:364:LYS:O	1:A:365:GLU:C	2.48	0.56
1:B:249:ILE:HB	1:B:305:PHE:HB2	1.87	0.56
1:B:108:TYR:O	1:B:109:VAL:HG23	2.07	0.55
1:B:287:LEU:O	1:B:288:PRO:C	2.50	0.55
1:A:108:TYR:O	1:A:109:VAL:HG23	2.07	0.54
1:A:269:THR:OG1	1:A:270:PRO:HD3	2.08	0.54
1:A:101:HIS:O	1:A:102:SER:C	2.52	0.53
1:A:261:ILE:HD11	1:A:305:PHE:CZ	2.43	0.53
1:A:312:PRO:HB2	1:A:314:THR:OG1	2.09	0.53
1:A:101:HIS:ND1	4:A:604:FAD:HM83	2.23	0.53
1:A:265:TRP:NE1	1:A:269:THR:HG21	2.24	0.53
1:A:60:PHE:HD1	1:A:65:MET:HE2	1.74	0.52
1:A:265:TRP:CH2	1:A:407:PHE:HB3	2.44	0.52

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:265:TRP:NE1	1:B:269:THR:HG21	2.24	0.52
1:B:510:ALA:HB3	1:B:522:TYR:OH	2.10	0.52
1:B:101:HIS:O	1:B:102:SER:C	2.51	0.52
1:B:201:ALA:HB1	1:B:537:VAL:HG21	1.91	0.52
1:B:268:VAL:HG11	1:B:324:PHE:HB2	1.92	0.52
1:A:77:LYS:HE2	5:A:708:HOH:O	2.10	0.51
1:A:228:GLY:HA2	1:A:538:PHE:CE2	2.45	0.51
1:A:510:ALA:HB3	1:A:522:TYR:OH	2.10	0.51
1:B:228:GLY:HA2	1:B:538:PHE:CE2	2.46	0.51
1:B:269:THR:OG1	1:B:270:PRO:HD3	2.09	0.51
1:B:287:LEU:O	1:B:289:ALA:N	2.44	0.51
1:B:129:VAL:HG13	1:B:237:LEU:HD11	1.92	0.51
1:A:268:VAL:HG11	1:A:324:PHE:HB2	1.92	0.51
1:B:288:PRO:O	1:B:289:ALA:CB	2.59	0.51
1:A:65:MET:HE3	1:A:66:PRO:HD2	1.92	0.50
1:A:346:PHE:O	1:A:348:GLU:HB2	2.11	0.50
1:A:291:MET:HG2	1:A:299:ILE:HD12	1.92	0.50
1:A:92:TYR:HB3	1:A:117:VAL:HG13	1.94	0.50
1:B:103:TYR:CZ	1:B:477:TYR:HD1	2.30	0.49
1:A:315:GLU:HA	1:A:318:SER:OG	2.12	0.49
1:A:96:VAL:O	4:A:604:FAD:H2B	2.13	0.49
1:A:287:LEU:O	1:A:291:MET:HE2	2.12	0.48
1:A:384:PRO:CG	1:B:384:PRO:HG3	2.43	0.48
1:B:265:TRP:CH2	1:B:407:PHE:HB3	2.47	0.48
1:A:160:PHE:CE1	1:A:235:ILE:HB	2.49	0.48
1:B:53:PHE:O	1:B:371:LYS:NZ	2.46	0.48
1:A:269:THR:HG22	1:A:278:LEU:HB3	1.95	0.48
1:B:269:THR:HG22	1:B:278:LEU:HB3	1.96	0.48
1:B:247:CYS:HB2	1:B:307:ALA:HB3	1.96	0.47
1:B:287:LEU:O	1:B:290:ASP:N	2.46	0.47
1:A:510:ALA:O	1:A:511:ARG:C	2.57	0.47
1:A:201:ALA:HB1	1:A:537:VAL:HG21	1.96	0.47
1:A:103:TYR:CZ	1:A:477:TYR:HD1	2.32	0.47
1:B:160:PHE:CE1	1:B:235:ILE:HB	2.50	0.47
1:A:141:GLY:O	1:A:366:ARG:NH2	2.40	0.47
1:A:291:MET:C	1:A:293:TYR:H	2.23	0.47
1:B:510:ALA:O	1:B:511:ARG:C	2.57	0.47
1:A:53:PHE:O	1:A:371:LYS:NZ	2.46	0.46
1:A:101:HIS:HB2	4:A:604:FAD:H5'2	1.97	0.46
1:B:476:ASN:OD1	4:B:601:FAD:O4'	2.24	0.46
1:A:295:ASN:C	1:A:297:THR:H	2.23	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:547:MET:O	1:A:548:LEU:C	2.59	0.46
1:A:427:ARG:O	1:A:430:ASN:ND2	2.34	0.46
1:B:182:LEU:O	1:B:183:SER:C	2.59	0.45
1:A:24:THR:O	1:A:25:ASN:C	2.59	0.45
1:B:261:ILE:HD11	1:B:305:PHE:CZ	2.51	0.45
1:A:245:THR:HG23	1:A:313:LYS:HG3	1.99	0.45
1:A:288:PRO:O	1:A:289:ALA:CB	2.65	0.45
1:A:162:ALA:O	1:A:180:GLY:HA3	2.17	0.45
1:A:245:THR:CG2	1:A:313:LYS:HG3	2.47	0.45
1:B:243:ILE:CG2	1:B:336:GLU:HB3	2.46	0.44
1:A:101:HIS:HB3	4:A:604:FAD:HM81	1.99	0.44
1:B:259:ALA:HB3	1:B:387:MET:HE1	2.00	0.44
1:A:183:SER:HA	1:A:187:GLY:O	2.18	0.44
1:A:315:GLU:HA	1:A:318:SER:HG	1.81	0.44
1:A:425:PRO:HB2	1:A:519:LEU:HD12	2.00	0.44
1:B:183:SER:HA	1:B:187:GLY:O	2.18	0.43
1:A:289:ALA:O	1:A:290:ASP:HB2	2.18	0.43
1:B:137:TRP:CZ2	1:B:234:LYS:HB2	2.53	0.43
1:B:141:GLY:O	1:B:366:ARG:NH2	2.39	0.43
1:B:159:ALA:HB1	1:B:339:TRP:CE2	2.54	0.43
1:B:101:HIS:CD2	1:B:168:VAL:HA	2.53	0.43
1:A:182:LEU:O	1:A:183:SER:C	2.59	0.43
1:A:313:LYS:HD3	1:A:336:GLU:HG3	1.99	0.43
1:A:173:HIS:ND1	4:A:604:FAD:O2'	2.40	0.43
1:A:402:LYS:HB3	1:A:439:GLN:O	2.19	0.43
1:B:425:PRO:HB2	1:B:519:LEU:HD12	1.99	0.42
1:B:60:PHE:HD1	1:B:65:MET:HE2	1.83	0.42
1:B:275:ASP:OD1	1:B:275:ASP:N	2.52	0.42
1:A:515:GLU:O	1:A:519:LEU:HA	2.20	0.42
1:A:463:THR:N	1:A:464:PRO:CD	2.83	0.42
1:A:287:LEU:O	1:A:290:ASP:N	2.52	0.42
1:A:289:ALA:O	1:A:290:ASP:CB	2.67	0.42
1:B:458:PHE:O	1:B:462:MET:HG2	2.20	0.42
1:A:101:HIS:CD2	1:A:168:VAL:HA	2.54	0.42
1:A:245:THR:HG21	1:A:316:VAL:HG21	2.02	0.42
1:A:186:PHE:CD1	1:A:238:LEU:HD22	2.54	0.42
1:A:337:MET:HE1	1:A:345:PHE:HD2	1.85	0.41
1:B:44:SER:HB2	1:B:47:TYR:HB2	2.02	0.41
1:B:65:MET:HE3	1:B:66:PRO:CD	2.50	0.41
1:B:515:GLU:O	1:B:519:LEU:HA	2.20	0.41
1:B:101:HIS:ND1	4:B:601:FAD:HM81	2.34	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:463:THR:N	1:B:464:PRO:CD	2.84	0.41
1:A:297:THR:O	1:A:298:PRO:C	2.62	0.41
1:A:384:PRO:HD2	1:B:431:LEU:HD21	2.03	0.41
1:A:247:CYS:HB2	1:A:307:ALA:HB3	2.01	0.41
1:A:458:PHE:O	1:A:462:MET:HG2	2.20	0.41
1:A:252:PRO:HG2	1:A:294:GLY:HA3	2.03	0.41
1:B:162:ALA:O	1:B:180:GLY:HA3	2.21	0.41
1:B:54:SER:HB2	1:B:97:ARG:CZ	2.50	0.41
1:B:287:LEU:HD21	1:B:302:PHE:CG	2.56	0.41
1:A:159:ALA:HB1	1:A:339:TRP:CE2	2.56	0.40
1:A:200:ASP:OD2	1:A:204:ARG:NH2	2.54	0.40
1:B:182:LEU:O	1:B:185:LYS:N	2.48	0.40
1:A:337:MET:HE1	1:A:345:PHE:CD2	2.56	0.40
1:A:280:VAL:HG22	1:A:305:PHE:CD2	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	493/560 (88%)	441 (90%)	46 (9%)	6 (1%)	10 13
1	B	491/560 (88%)	435 (89%)	48 (10%)	8 (2%)	7 9
All	All	984/1120 (88%)	876 (89%)	94 (10%)	14 (1%)	9 11

All (14) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	288	PRO
1	A	290	ASP
1	B	288	PRO
1	B	289	ALA

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Mol	Chain	Res	Type
1	A	25	ASN
1	A	478	LEU
1	B	443	GLU
1	B	478	LEU
1	B	291	MET
1	B	294	GLY
1	A	294	GLY
1	B	295	ASN
1	A	425	PRO
1	B	425	PRO

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	401/475 (84%)	383 (96%)	18 (4%)	24	38
1	B	403/475 (85%)	387 (96%)	16 (4%)	28	42
All	All	804/950 (85%)	770 (96%)	34 (4%)	26	40

All (34) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	109	VAL
1	A	236	ARG
1	A	261	ILE
1	A	275	ASP
1	A	290	ASP
1	A	296	THR
1	A	313	LYS
1	A	321	ASN
1	A	340	VAL
1	A	348	GLU
1	A	366	ARG
1	A	381	VAL
1	A	398	GLU

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Mol	Chain	Res	Type
1	A	405	LEU
1	A	437	LEU
1	A	447	MET
1	A	478	LEU
1	A	543	SER
1	B	27	SER
1	B	109	VAL
1	B	261	ILE
1	B	275	ASP
1	B	287	LEU
1	B	298	PRO
1	B	318	SER
1	B	340	VAL
1	B	366	ARG
1	B	373	PHE
1	B	381	VAL
1	B	405	LEU
1	B	437	LEU
1	B	443	GLU
1	B	478	LEU
1	B	543	SER

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	36	HIS
1	A	226	ASN
1	B	25	ASN
1	B	52	HIS
1	B	226	ASN
1	B	295	ASN
1	B	304	GLN
1	B	439	GLN

5.3.3 RNA

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates (i)

There are no oligosaccharides in this entry.

5.6 Ligand geometry (i)

5 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	B	601	-	56,58,58	0.59	0	81,89,89	0.91	5 (6%)
3	NAG	A	602	1	14,14,15	0.31	0	17,19,21	1.48	2 (11%)
2	SO4	A	601	-	4,4,4	0.32	0	6,6,6	0.11	0
3	NAG	A	603	1	14,14,15	0.30	0	17,19,21	1.36	4 (23%)
4	FAD	A	604	-	56,58,58	0.53	0	81,89,89	0.82	3 (3%)

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	B	601	-	-	9/34/50/50	0/6/6/6
3	NAG	A	603	1	-	4/6/23/26	0/1/1/1
4	FAD	A	604	-	-	5/34/50/50	0/6/6/6
3	NAG	A	602	1	-	4/6/23/26	0/1/1/1

There are no bond length outliers.

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	A	602	NAG	C1-C2-N2	4.38	117.97	110.49
4	B	601	FAD	C1'-C2'-C3'	3.76	120.28	109.79
4	A	604	FAD	O4'-C4'-C5'	-2.72	103.80	109.92
3	A	602	NAG	C4-C3-C2	-2.60	107.21	111.02
3	A	603	NAG	O5-C1-C2	-2.58	107.21	111.29
3	A	603	NAG	C4-C3-C2	2.47	114.64	111.02
3	A	603	NAG	C1-C2-N2	2.40	114.59	110.49
4	B	601	FAD	O5'-C5'-C4'	2.40	115.77	109.36
4	A	604	FAD	O2B-C2B-C3B	2.36	119.44	111.82
4	B	601	FAD	O2P-P-O1P	2.34	123.83	112.24
4	B	601	FAD	O2'-C2'-C3'	-2.28	103.56	109.10
4	B	601	FAD	O3'-C3'-C2'	2.22	114.18	108.81
4	A	604	FAD	C5'-C4'-C3'	2.22	116.49	112.20
3	A	603	NAG	O3-C3-C2	-2.12	105.08	109.47

There are no chirality outliers.

All (22) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	602	NAG	C8-C7-N2-C2
3	A	602	NAG	O7-C7-N2-C2
4	B	601	FAD	C2'-C3'-C4'-O4'
4	B	601	FAD	O3'-C3'-C4'-O4'
4	B	601	FAD	O3'-C3'-C4'-C5'
4	B	601	FAD	C5'-O5'-P-O3P
3	A	602	NAG	C4-C5-C6-O6
4	A	604	FAD	C2'-C3'-C4'-C5'
4	B	601	FAD	C2'-C3'-C4'-C5'
3	A	603	NAG	C8-C7-N2-C2
3	A	603	NAG	O7-C7-N2-C2
3	A	602	NAG	O5-C5-C6-O6
4	A	604	FAD	O3'-C3'-C4'-C5'
4	A	604	FAD	O3'-C3'-C4'-O4'
4	A	604	FAD	C2'-C3'-C4'-O4'
3	A	603	NAG	C4-C5-C6-O6
3	A	603	NAG	O5-C5-C6-O6
4	A	604	FAD	C5'-O5'-P-O3P
4	B	601	FAD	C5'-O5'-P-O1P
4	B	601	FAD	C5'-O5'-P-O2P
4	B	601	FAD	O4B-C4B-C5B-O5B
4	B	601	FAD	C3'-C4'-C5'-O5'

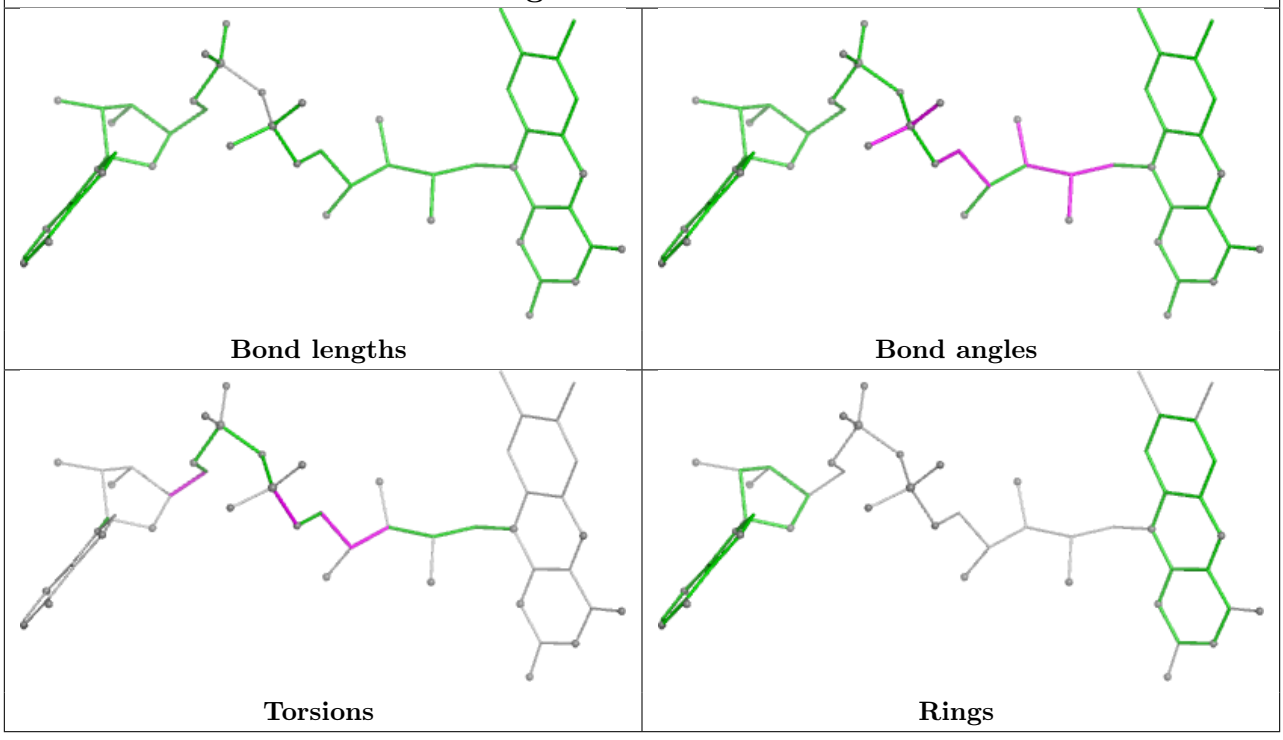
There are no ring outliers.

2 monomers are involved in 10 short contacts:

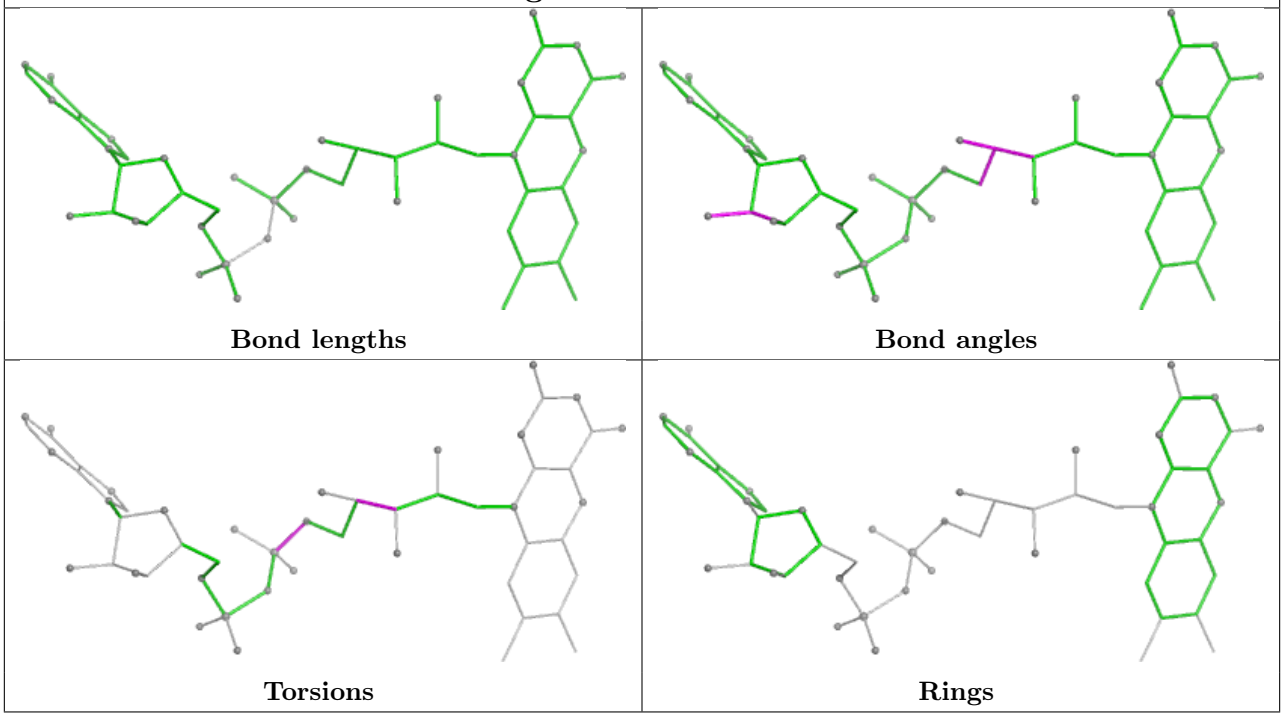
Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	601	FAD	4	0
4	A	604	FAD	6	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand FAD B 601



Ligand FAD A 604



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^{th} percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2			OWAB(Å^2)	Q<0.9
1	A	498/560 (88%)	0.94	51 (10%)	12	11	19, 47, 71, 101	1 (0%)
1	B	497/560 (88%)	1.00	53 (10%)	11	10	20, 48, 70, 95	0
All	All	995/1120 (88%)	0.97	104 (10%)	11	11	19, 48, 71, 101	1 (0%)

All (104) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	156	ASP	6.0
1	A	287	LEU	5.8
1	B	298	PRO	4.1
1	A	24	THR	3.8
1	B	547	MET	3.8
1	A	548	LEU	3.7
1	A	307	ALA	3.6
1	B	287	LEU	3.6
1	B	376	GLY	3.6
1	A	306	ASN	3.6
1	B	397	LEU	3.5
1	B	296	THR	3.4
1	A	163	GLY	3.4
1	A	181	LEU	3.4
1	B	142	ALA	3.4
1	A	486	MET	3.2
1	B	295	ASN	3.2
1	B	523	ASP	3.2
1	B	393	PHE	3.1
1	B	465	PHE	3.1
1	A	358	GLY	3.1
1	B	24	THR	3.0
1	A	131	LEU	3.0
1	A	405	LEU	3.0

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Mol	Chain	Res	Type	RSRZ
1	A	418	SER	3.0
1	A	446	TYR	3.0
1	B	148	TYR	3.0
1	A	363	LEU	3.0
1	B	104	GLU	2.9
1	B	513	TRP	2.9
1	B	181	LEU	2.9
1	B	380	TYR	2.9
1	A	360	ILE	2.8
1	A	159	ALA	2.8
1	A	149	TYR	2.8
1	B	217	TRP	2.8
1	B	299	ILE	2.8
1	A	241	PRO	2.8
1	A	275	ASP	2.8
1	A	140	GLY	2.7
1	B	198	LEU	2.7
1	B	484	VAL	2.7
1	B	522	TYR	2.7
1	A	277	THR	2.7
1	B	512	ALA	2.7
1	B	374	PHE	2.6
1	B	81	VAL	2.6
1	B	165	GLY	2.6
1	A	46	ASN	2.6
1	B	483	GLY	2.5
1	B	48	PHE	2.4
1	B	297	THR	2.4
1	A	339	TRP	2.4
1	A	242	LYS	2.4
1	B	346	PHE	2.4
1	B	201	ALA	2.4
1	B	425	PRO	2.4
1	A	372	GLY	2.4
1	A	317	LEU	2.4
1	B	446	TYR	2.4
1	A	35	VAL	2.4
1	A	513	TRP	2.4
1	B	243	ILE	2.3
1	B	363	LEU	2.3
1	B	538	PHE	2.3
1	A	316	VAL	2.3

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Mol	Chain	Res	Type	RSRZ
1	A	151	ILE	2.3
1	A	525	LEU	2.3
1	A	302	PHE	2.3
1	B	227	TRP	2.3
1	A	96	VAL	2.3
1	A	257	TYR	2.3
1	B	293	TYR	2.3
1	A	261	ILE	2.3
1	A	388	ASP	2.3
1	A	109	VAL	2.3
1	B	343	ALA	2.2
1	B	261	ILE	2.2
1	B	127	VAL	2.2
1	B	105	GLY	2.2
1	A	164	SER	2.2
1	A	132	ASP	2.2
1	B	64	PHE	2.2
1	A	154	VAL	2.2
1	A	152	ALA	2.2
1	A	459	TYR	2.2
1	B	267	ILE	2.2
1	B	401	PRO	2.2
1	B	388	ASP	2.1
1	A	373	PHE	2.1
1	B	431	LEU	2.1
1	A	45	ARG	2.1
1	B	108	TYR	2.1
1	A	547	MET	2.1
1	B	368	MET	2.1
1	A	230	VAL	2.1
1	B	398	GLU	2.1
1	B	302	PHE	2.0
1	B	385	VAL	2.0
1	A	237	LEU	2.0
1	B	349	LEU	2.0
1	A	155	SER	2.0
1	A	288	PRO	2.0
1	A	340	VAL	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)

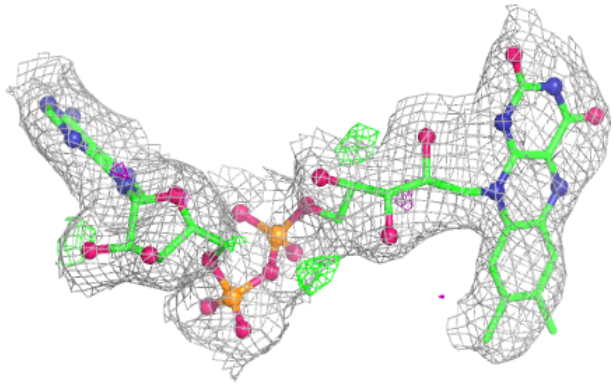
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9'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

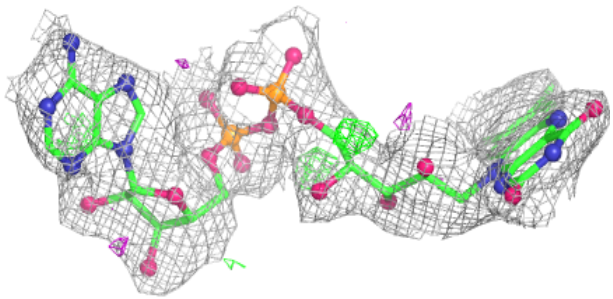
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	SO4	A	601	5/5	0.76	0.17	74,78,83,84	0
3	NAG	A	603	14/15	0.85	0.10	44,52,54,54	0
3	NAG	A	602	14/15	0.87	0.11	31,37,51,59	0
4	FAD	A	604	53/53	0.93	0.10	28,45,59,60	0
4	FAD	B	601	53/53	0.94	0.09	22,33,42,43	0

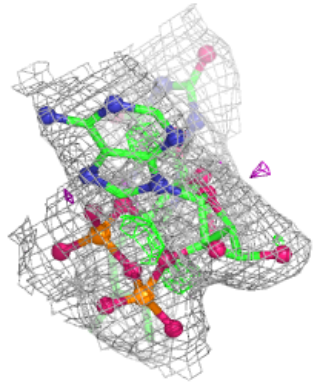
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around FAD A 604:

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

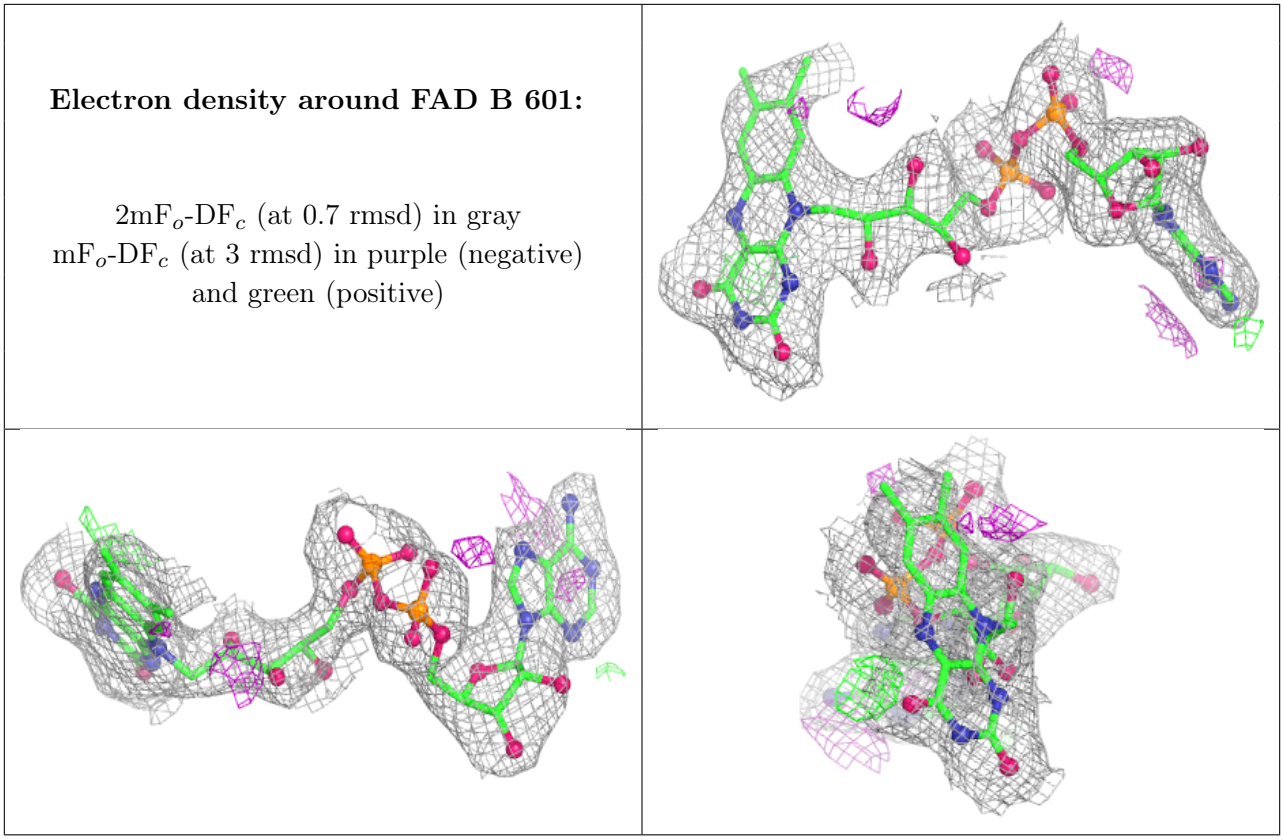






Electron density around FAD B 601:

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



6.5 Other polymers (i)

There are no such residues in this entry.