



Full wwPDB X-ray Structure Validation Report ⓘ

Jun 12, 2024 – 06:19 PM EDT

PDB ID : 3FRF
Title : S. aureus DHFR complexed with NADPH and iclaprim
Authors : Oefner, C.; Dale-Glenn, E.
Deposited on : 2009-01-08
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 : 4.02b-467
Mogul : 2022.3.0, CSD as543be (2022)
Xtriage (Phenix) : 1.20.1
EDS : 2.36.2
buster-report : 1.1.7 (2018)
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac : 5.8.0158
CCP4 : 7.0.044 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.36.2

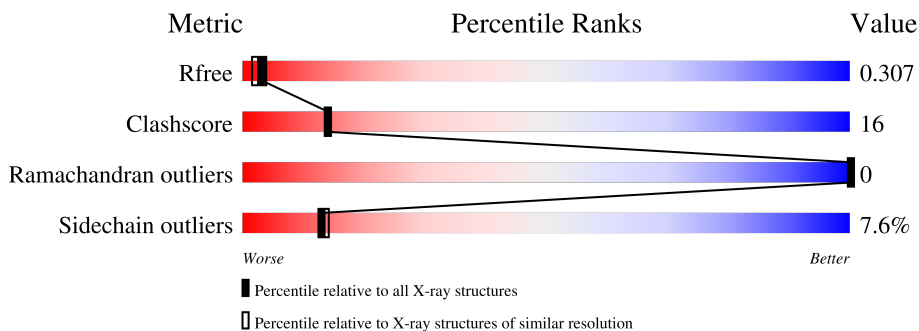
1 Overall quality at a glance

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}	130704	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (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 $\leq 5\%$.

Mol	Chain	Length	Quality of chain
1	X	158	

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 1497 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 Dihydrofolate reductase.

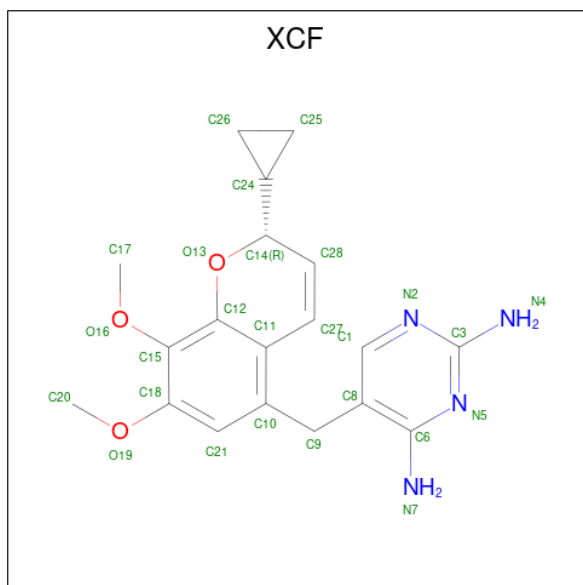
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	X	158	1281	828	215	235	3	0	0	0

- Molecule 2 is NADPH DIHYDRO-NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NDP) (formula: $C_{21}H_{30}N_7O_{17}P_3$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	X	1	48	21	7	17	3	0	0

- Molecule 3 is 5-[[[(2R)-2-cyclopropyl-7,8-dimethoxy-2H-chromen-5-yl]methyl]pyrimidine-2,4-diamine (three-letter code: XCF) (formula: $C_{19}H_{22}N_4O_3$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	X	1	26	19	4	3	0	0

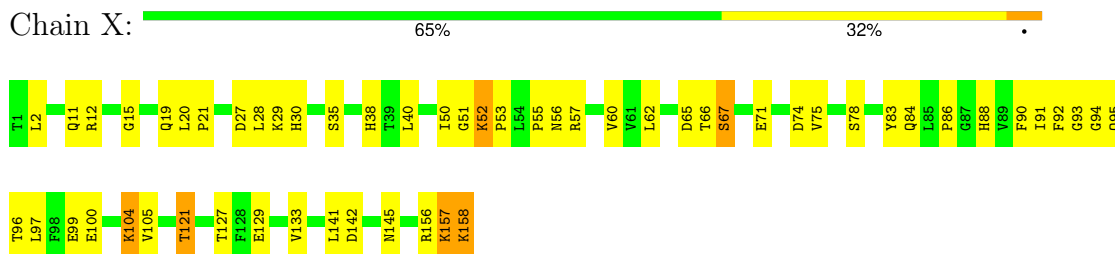
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	X	142	142	142	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. 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. 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: Dihydrofolate reductase



4 Data and refinement statistics

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α , β , γ	79.28Å 79.28Å 108.17Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 2.20 19.82 – 2.11	Depositor EDS
% Data completeness (in resolution range)	93.1 (20.00-2.20) 98.1 (19.82-2.11)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.77 (at 2.11Å)	Xtrriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.228 , 0.287 0.309 , 0.307	Depositor DCC
R_{free} test set	567 reflections (4.79%)	wwPDB-VP
Wilson B-factor (Å ²)	25.6	Xtrriage
Anisotropy	0.004	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 63.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.87	EDS
Total number of atoms	1497	wwPDB-VP
Average B, all atoms (Å ²)	48.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.56% 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: NDP, XCF

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	X	0.27	0/1314	0.39	0/1781

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
1	X	0	2

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	X	157	LYS	Peptide
1	X	91	ILE	Peptide

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	X	1281	0	1276	41	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	X	48	0	26	8	0
3	X	26	0	22	4	0
4	X	142	0	0	7	3
All	All	1497	0	1324	42	3

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 16.

All (42) 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:X:95:GLN:O	1:X:99:GLU:HG3	1.78	0.83
1:X:28:LEU:HD22	3:X:300:XCF:H14	1.59	0.83
1:X:62:LEU:HD21	2:X:301:NDP:C5A	2.12	0.80
1:X:133:VAL:HG11	4:X:274:HOH:O	1.82	0.78
1:X:52:LYS:HB2	1:X:53:PRO:HD2	1.67	0.77
1:X:156:ARG:O	4:X:236:HOH:O	2.05	0.73
1:X:19:GLN:NE2	4:X:183:HOH:O	2.10	0.73
1:X:60:VAL:HG22	1:X:74:ASP:HB2	1.75	0.68
1:X:62:LEU:CD2	2:X:301:NDP:C5A	2.77	0.62
1:X:92:PHE:CZ	3:X:300:XCF:H9A	2.37	0.60
1:X:35:SER:HB2	1:X:40:LEU:HD21	1.86	0.56
2:X:301:NDP:H42N	3:X:300:XCF:H9	1.87	0.56
1:X:84:GLN:HB2	4:X:223:HOH:O	2.06	0.55
1:X:142:ASP:OD2	1:X:145:ASN:N	2.39	0.55
1:X:38:HIS:O	1:X:57:ARG:HB2	2.07	0.54
1:X:62:LEU:HD21	2:X:301:NDP:C6A	2.37	0.53
1:X:127:THR:HG22	1:X:129:GLU:H	1.74	0.53
1:X:86:PRO:HD2	4:X:296:HOH:O	2.07	0.52
1:X:142:ASP:OD2	1:X:142:ASP:C	2.47	0.52
1:X:93:GLY:HA3	2:X:301:NDP:H5N	1.92	0.52
1:X:55:PRO:O	1:X:56:ASN:HB2	2.10	0.51
1:X:62:LEU:O	2:X:301:NDP:H1B	2.10	0.51
1:X:66:THR:HG22	4:X:262:HOH:O	2.12	0.50
1:X:50:ILE:HG13	1:X:51:GLY:N	2.26	0.49
1:X:96:THR:HG22	1:X:100:GLU:OE2	2.13	0.48
1:X:11:GLN:O	1:X:12:ARG:HB2	2.14	0.47
1:X:121:THR:HG21	2:X:301:NDP:H4D	1.95	0.47
1:X:15:GLY:HA3	1:X:121:THR:OG1	2.14	0.47
1:X:27:ASP:O	1:X:30:HIS:HB3	2.15	0.46
1:X:96:THR:O	1:X:100:GLU:HG3	2.15	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:X:20:LEU:HA	1:X:21:PRO:HD3	1.83	0.46
1:X:2:LEU:HG	1:X:105:VAL:HG12	1.97	0.46
1:X:104:LYS:HB3	1:X:104:LYS:HE2	1.72	0.45
1:X:30:HIS:HE1	4:X:166:HOH:O	1.98	0.45
1:X:93:GLY:HA2	1:X:94:GLY:HA2	1.79	0.43
1:X:83:TYR:OH	1:X:104:LYS:HE2	2.19	0.42
1:X:88:HIS:CE1	1:X:90:PHE:CZ	3.08	0.42
1:X:92:PHE:CZ	3:X:300:XCF:H27	2.55	0.42
1:X:62:LEU:HD23	2:X:301:NDP:C8A	2.49	0.42
1:X:65:ASP:OD2	1:X:67:SER:HB2	2.19	0.41
1:X:157:LYS:O	1:X:158:LYS:HB2	2.20	0.41
1:X:52:LYS:HB2	1:X:53:PRO:CD	2.45	0.41

All (3) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:X:196:HOH:O	4:X:196:HOH:O[11_655]	0.87	1.33
4:X:274:HOH:O	4:X:285:HOH:O[5_554]	1.44	0.76
4:X:274:HOH:O	4:X:284:HOH:O[5_554]	2.04	0.16

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	X	156/158 (99%)	150 (96%)	6 (4%)	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	X	145/145 (100%)	134 (92%)	11 (8%)	13 14

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	X	29	LYS
1	X	52	LYS
1	X	67	SER
1	X	71	GLU
1	X	75	VAL
1	X	78	SER
1	X	97	LEU
1	X	104	LYS
1	X	121	THR
1	X	141	LEU
1	X	158	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	X	11	GLN
1	X	30	HIS
1	X	56	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 monosaccharides in this entry.

5.6 Ligand geometry [i](#)

2 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
2	NDP	X	301	-	47,52,52	1.80	6 (12%)	61,80,80	1.16	4 (6%)
3	XCF	X	300	-	28,29,29	1.43	4 (14%)	39,42,42	2.04	16 (41%)

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	NDP	X	301	-	-	2/30/77/77	0/5/5/5
3	XCF	X	300	-	-	3/10/23/23	0/4/4/4

All (10) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	X	301	NDP	O7N-C7N	7.15	1.41	1.24
2	X	301	NDP	C4N-C3N	-5.50	1.39	1.50
2	X	301	NDP	C2A-N3A	4.11	1.38	1.32
3	X	300	XCF	C6-N5	4.03	1.40	1.35
2	X	301	NDP	C4N-C5N	-3.67	1.39	1.49
3	X	300	XCF	C1-N2	3.51	1.41	1.34
3	X	300	XCF	C3-N2	3.38	1.40	1.35
3	X	300	XCF	C3-N5	3.23	1.41	1.35
2	X	301	NDP	C2A-N1A	2.64	1.38	1.33
2	X	301	NDP	C6N-C5N	2.04	1.39	1.33

All (20) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	X	300	XCF	N2-C3-N5	-6.25	118.74	125.70
2	X	301	NDP	N3A-C2A-N1A	-6.09	120.41	128.67
3	X	300	XCF	C12-O13-C14	3.49	124.02	115.25
3	X	300	XCF	N4-C3-N2	3.25	120.76	117.40
3	X	300	XCF	O16-C15-C18	-3.09	115.69	120.12
3	X	300	XCF	C1-C8-C6	2.97	119.20	115.55
3	X	300	XCF	C1-N2-C3	2.81	121.24	116.29
3	X	300	XCF	C9-C8-C6	-2.73	118.28	122.06
3	X	300	XCF	O13-C14-C24	2.41	111.96	107.40
3	X	300	XCF	C10-C11-C27	-2.41	121.20	124.67
3	X	300	XCF	C17-O16-C15	2.40	121.26	114.74
3	X	300	XCF	O13-C12-C11	-2.24	119.03	122.29
2	X	301	NDP	C1D-N1N-C2N	-2.21	117.49	121.14
3	X	300	XCF	O13-C14-C28	2.19	113.49	109.43
3	X	300	XCF	N4-C3-N5	2.18	120.50	117.22
3	X	300	XCF	O16-C15-C12	2.18	125.31	120.35
3	X	300	XCF	C3-N5-C6	2.18	119.89	117.28
3	X	300	XCF	C8-C1-N2	-2.15	120.34	123.83
2	X	301	NDP	C3N-C2N-N1N	-2.14	120.06	123.20
2	X	301	NDP	O2A-PA-O3	2.02	112.74	107.27

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	X	300	XCF	C28-C14-C24-C26
3	X	300	XCF	C18-C15-O16-C17
2	X	301	NDP	O4D-C1D-N1N-C2N
2	X	301	NDP	C2B-O2B-P2B-O3X
3	X	300	XCF	C12-C15-O16-C17

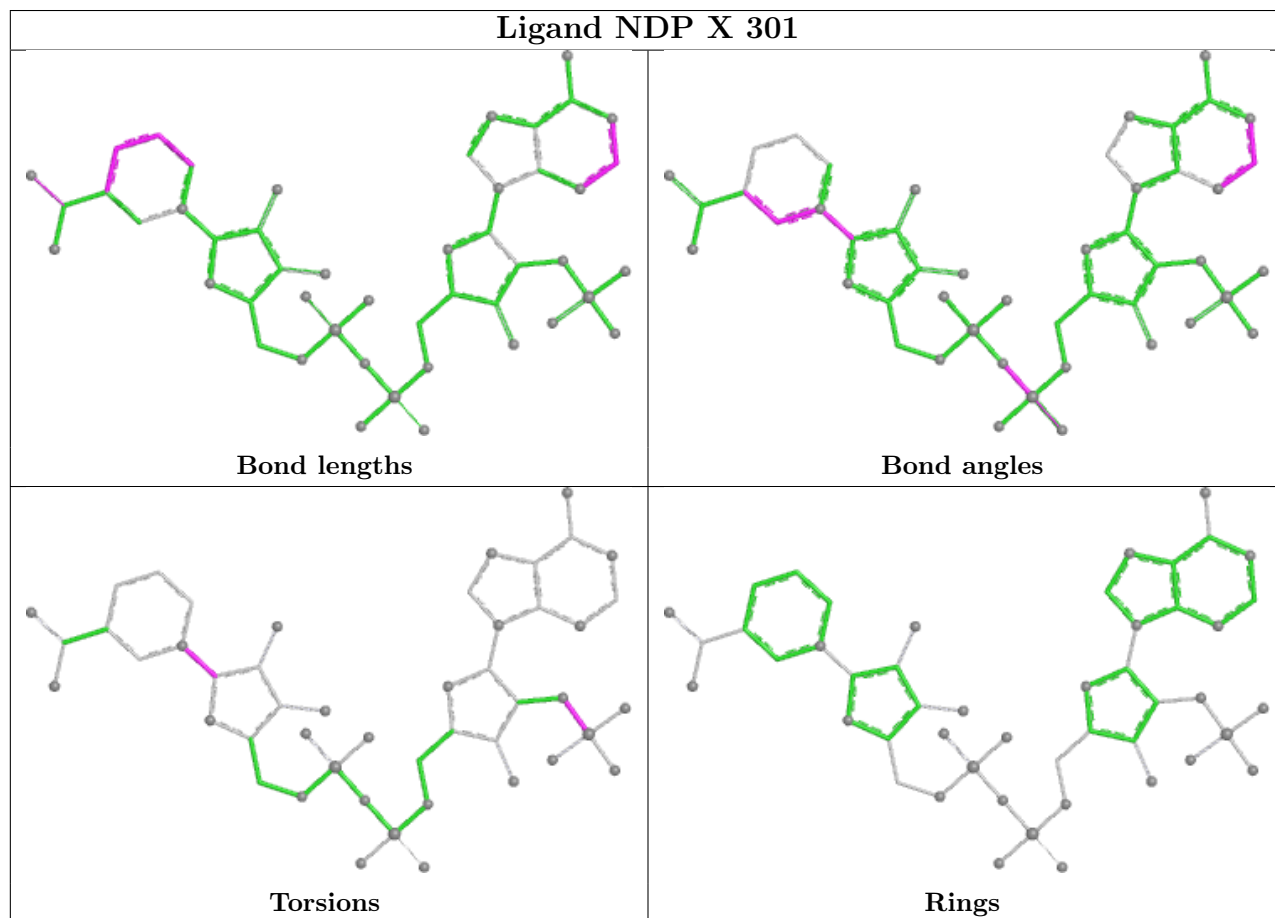
There are no ring outliers.

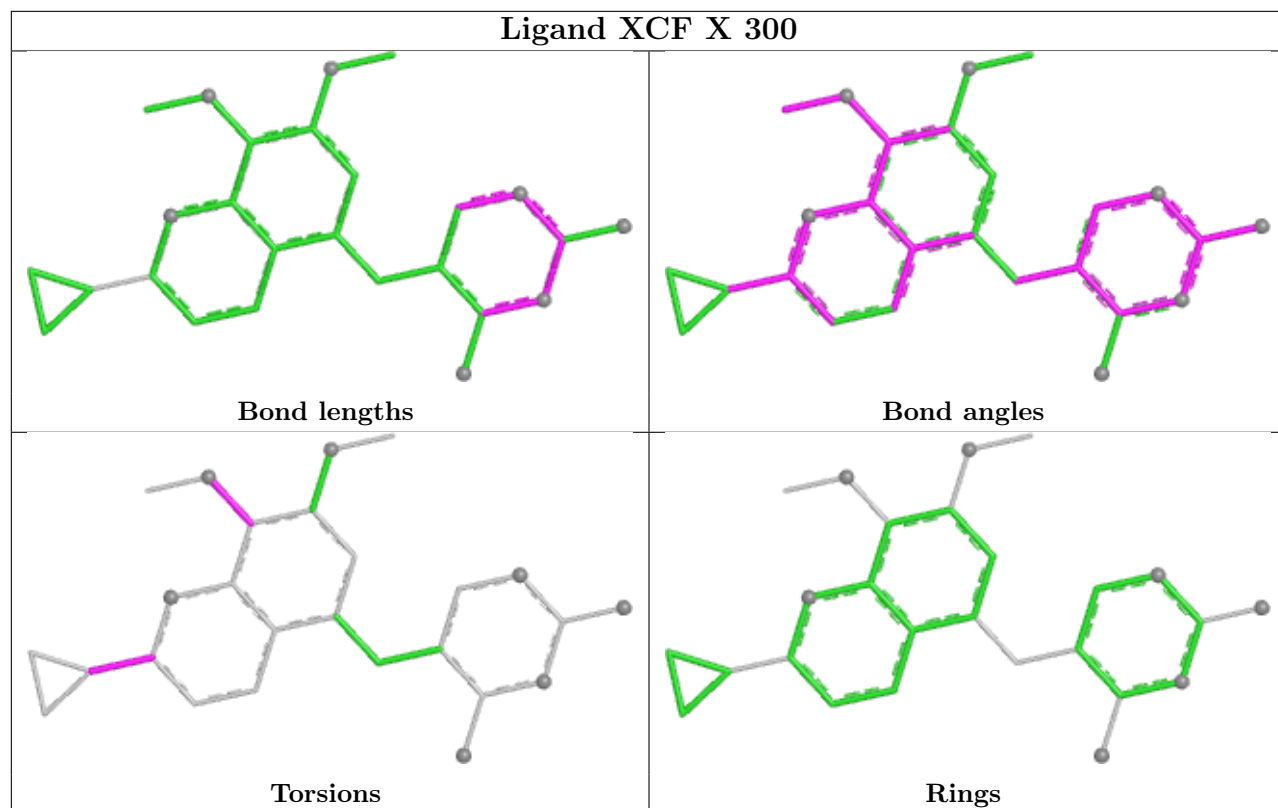
2 monomers are involved in 11 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	X	301	NDP	8	0
3	X	300	XCF	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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.

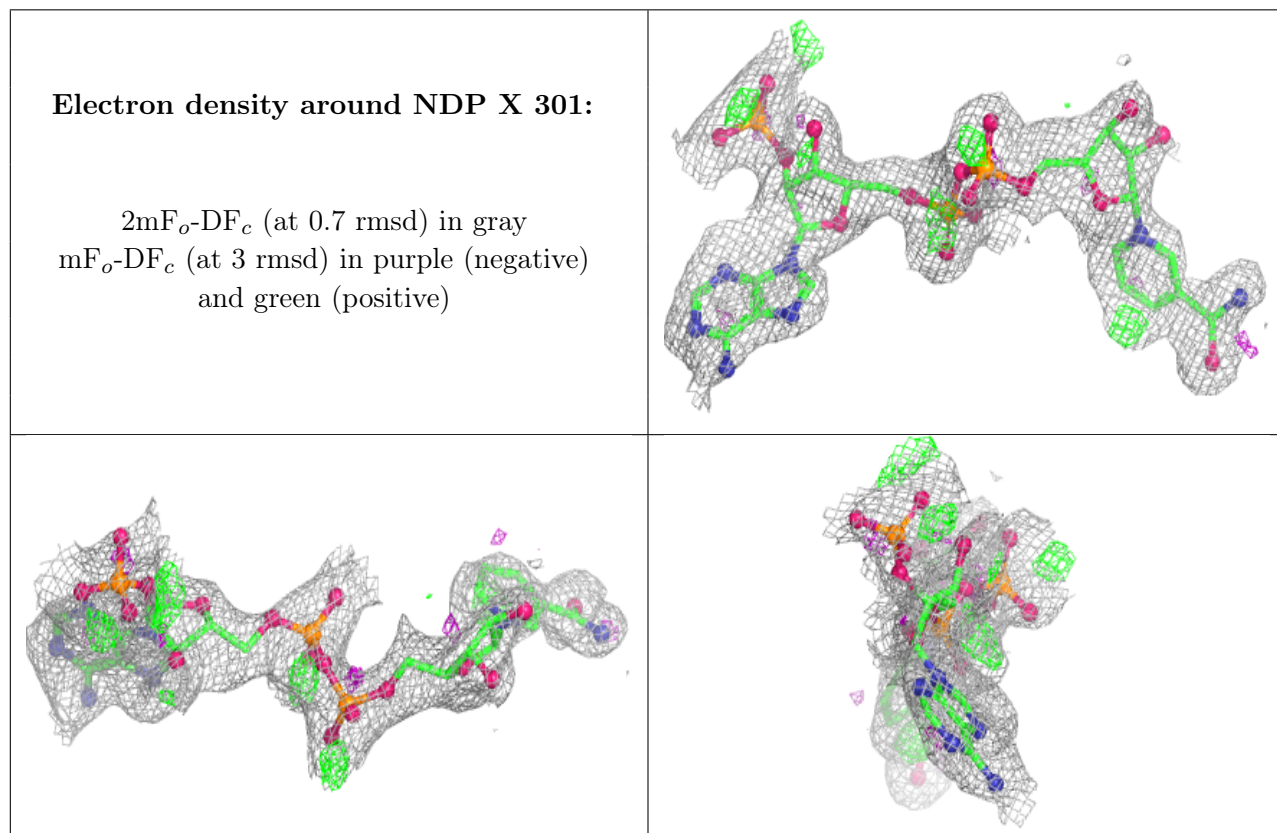
6.3 Carbohydrates [i](#)

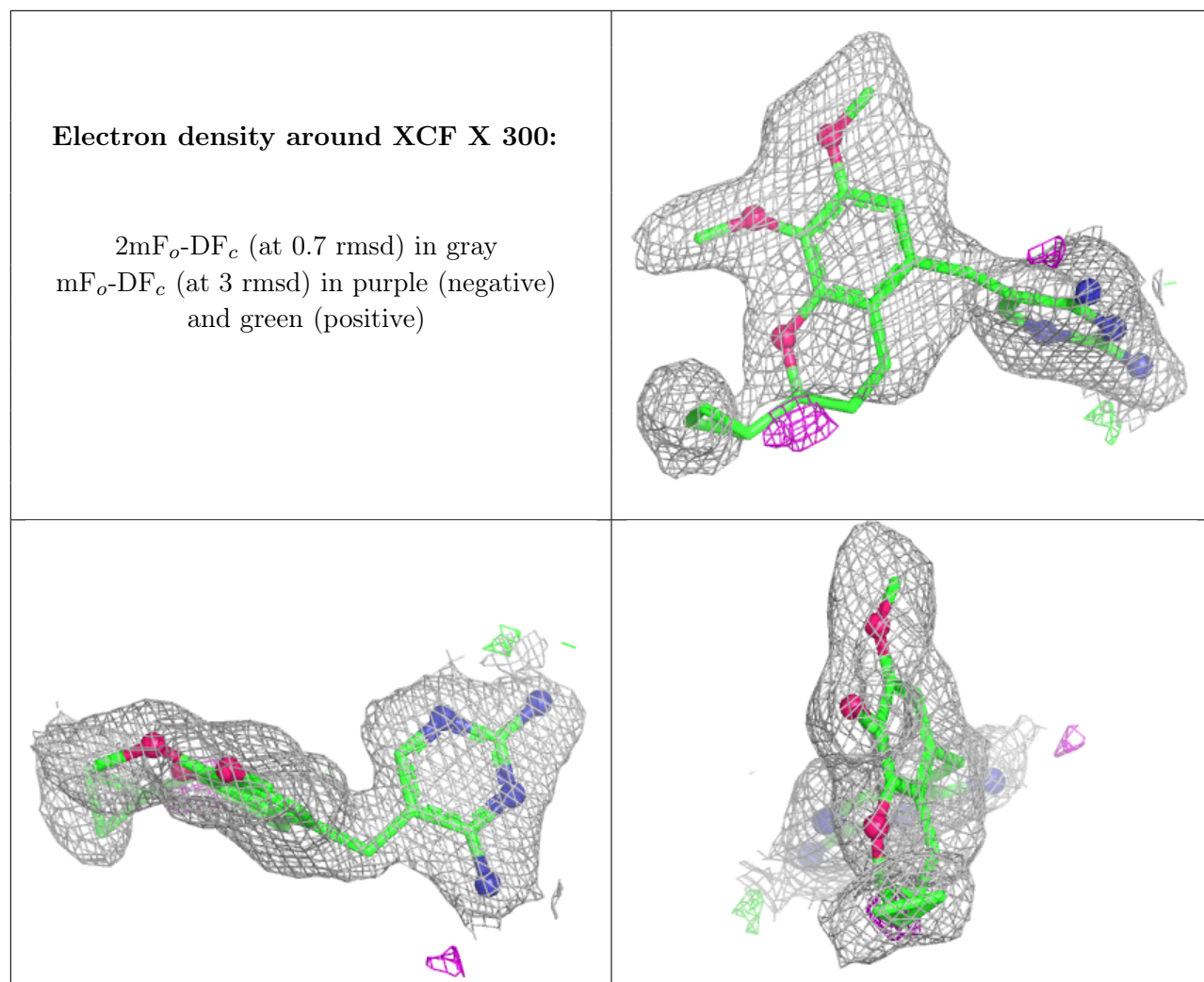
Unable to reproduce the depositors R factor - this section is therefore empty.

6.4 Ligands [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

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.





6.5 Other polymers [i](#)

Unable to reproduce the depositor's R factor - this section is therefore empty.