wwPDB X-ray Structure Validation Summary Report (i)

Mar 3, 2025 – 02:08 PM EST

PDB ID	:	9EC2
Title	:	Crystal structure of SAMHD1 dimer bound to an inhibitor obtained from high-throughput chemical tethering to the guanine antiviral acyclovir
Authors	:	Egleston, M.; Dong, L.; Howlader, A.H.; Bhat, S.; Orris, B.; Lopez-Rovira, L.M.; Bianchet, M.A.; Greenberg, M.M.; Stivers, J.T.
Deposited on	:	2024-11-13
Resolution	:	2.72 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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:

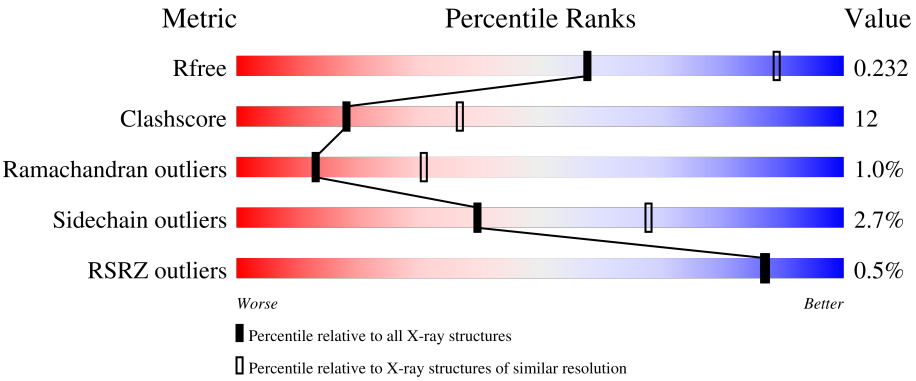
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.21
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.004 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.41.4

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 2.72 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}	164625	4050 (2.74-2.70)
Clashscore	180529	4439 (2.74-2.70)
Ramachandran outliers	177936	4374 (2.74-2.70)
Sidechain outliers	177891	4375 (2.74-2.70)
RSRZ outliers	164620	4050 (2.74-2.70)

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	516	% 66% 21% • 12%
1	B	516	65% 18% • 16%
1	C	516	59% 22% • 17%
1	D	516	67% 20% • 12%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 29137 atoms, of which 14442 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.

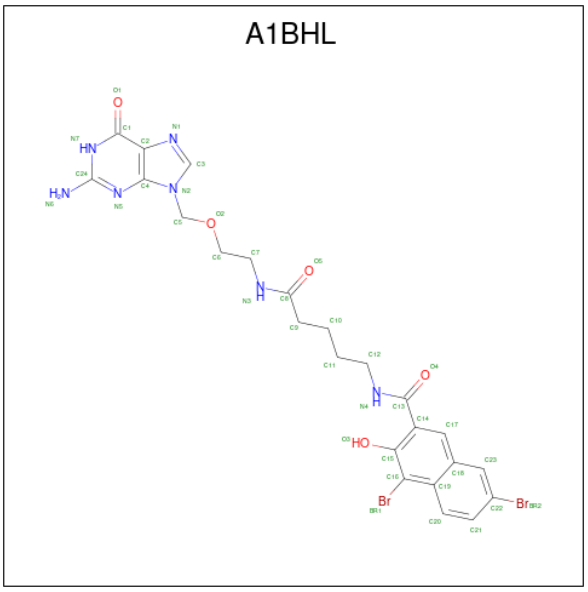
- Molecule 1 is a protein called Deoxynucleoside triphosphate triphosphohydrolase SAMHD1.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	453	Total	C	H	N	O	S	0	0	0
			7369	2368	3668	642	671	20			
1	B	435	Total	C	H	N	O	S	0	0	0
			7057	2265	3511	614	648	19			
1	C	430	Total	C	H	N	O	S	0	0	0
			7006	2252	3491	609	636	18			
1	D	452	Total	C	H	N	O	S	0	0	0
			7375	2370	3672	642	671	20			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	111	SER	-	expression tag	UNP Q9Y3Z3
A	112	MET	-	expression tag	UNP Q9Y3Z3
B	111	SER	-	expression tag	UNP Q9Y3Z3
B	112	MET	-	expression tag	UNP Q9Y3Z3
C	111	SER	-	expression tag	UNP Q9Y3Z3
C	112	MET	-	expression tag	UNP Q9Y3Z3
D	111	SER	-	expression tag	UNP Q9Y3Z3
D	112	MET	-	expression tag	UNP Q9Y3Z3

- Molecule 2 is N-[5-({2-[(2-amino-6-oxo-1,6-dihydro-9H-purin-9-yl)methoxy]ethyl}amino)-5-oxopentyl]-4,7-dibromo-3-hydroxynaphthalene-2-carboxamide (three-letter code: A1BHL) (formula: $C_{24}H_{25}Br_2N_7O_5$).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
2	A	1	Total	Br	C	H	N	O	0	0
			63	2	24	25	7	5		
2	B	1	Total	Br	C	H	N	O	0	0
			63	2	24	25	7	5		
2	B	1	Total	Br	C	H	N	O	0	0
			63	2	24	25	7	5		
2	C	1	Total	Br	C	H	N	O	0	0
			63	2	24	25	7	5		

- Molecule 3 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Fe	0	0
			1	1		
3	B	1	Total	Fe	0	0
			1	1		
3	C	1	Total	Fe	0	0
			1	1		
3	D	1	Total	Fe	0	0
			1	1		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	26	Total	O	0	0
			26	26		

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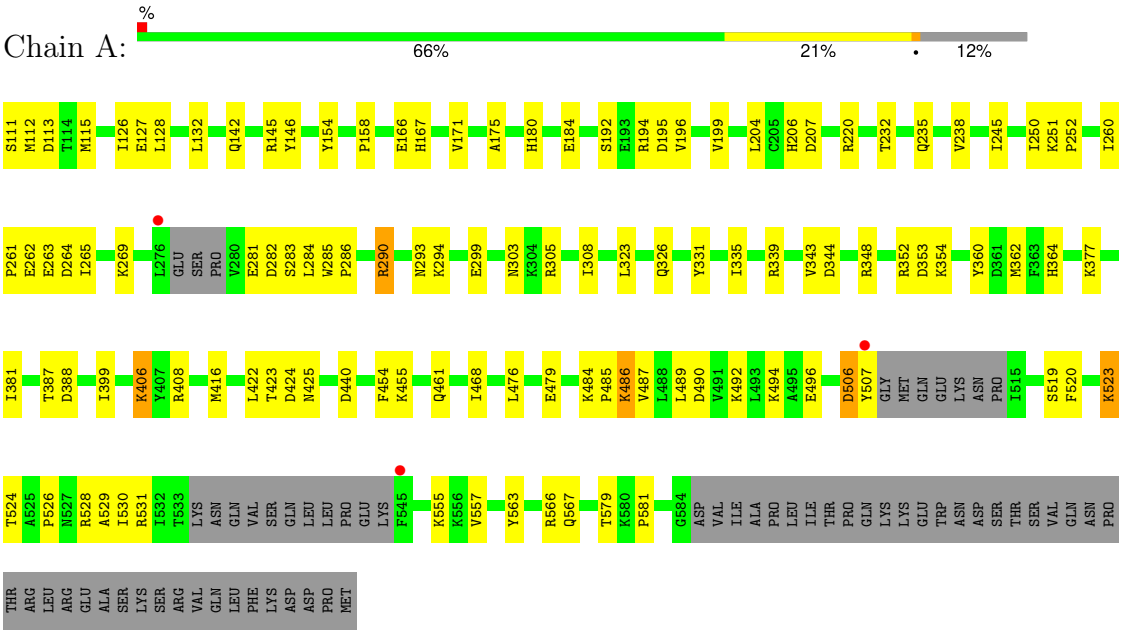
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	B	14	Total O 14 14	0	0
4	C	14	Total O 14 14	0	0
4	D	20	Total O 20 20	0	0

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.

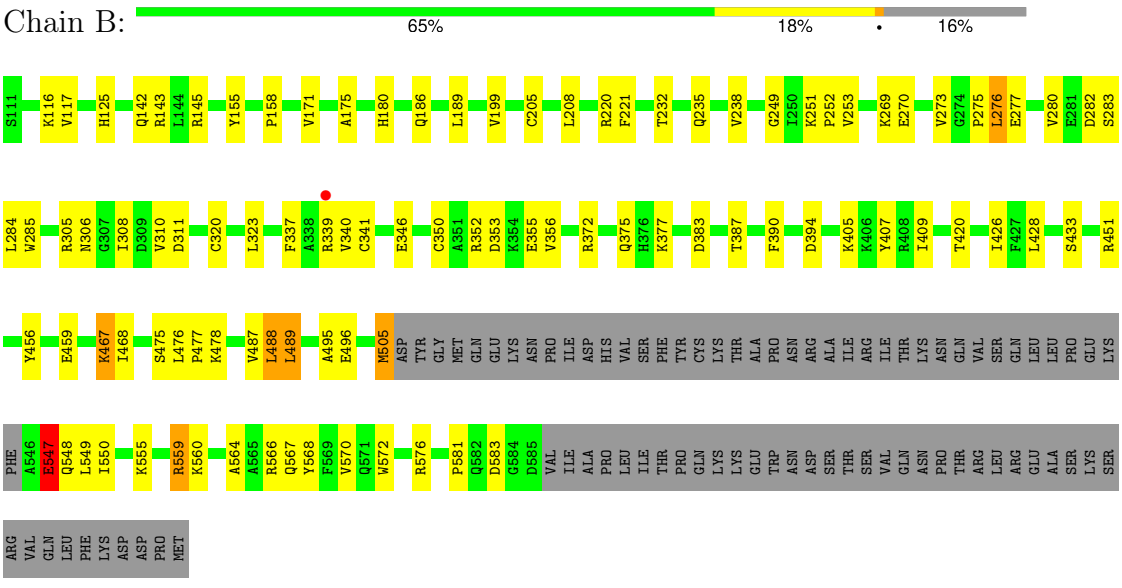
• Molecule 1: Deoxynucleoside triphosphate triphosphohydrolase SAMHD1

Chain A:



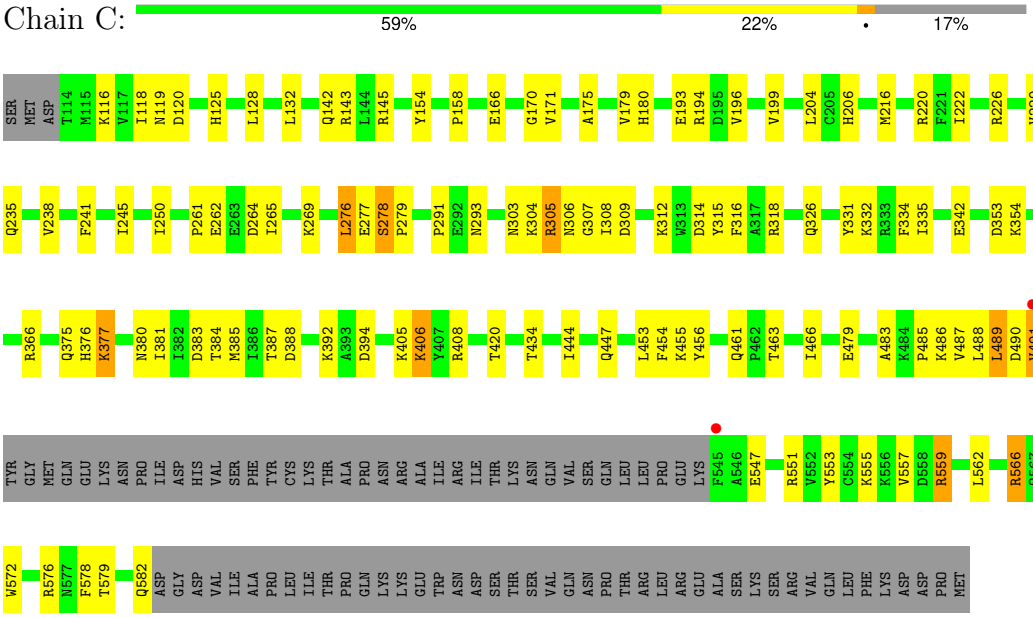
• Molecule 1: Deoxynucleoside triphosphate triphosphohydrolase SAMHD1

Chain B:



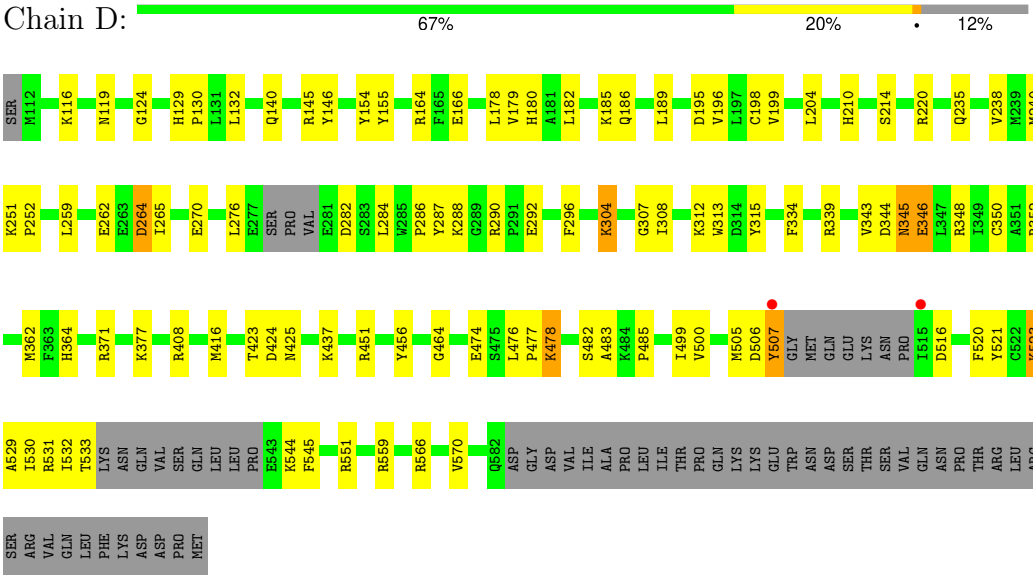
• Molecule 1: Deoxynucleoside triphosphate triphosphohydrolase SAMHD1

Chain C:



• Molecule 1: Deoxynucleoside triphosphate triphosphohydrolase SAMHD1

Chain D:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α, β, γ	81.35Å 94.27Å 96.58Å 73.05° 71.48° 65.20°	Depositor
Resolution (Å)	33.65 – 2.72 33.65 – 2.72	Depositor EDS
% Data completeness (in resolution range)	98.7 (33.65-2.72) 98.7 (33.65-2.72)	Depositor EDS
R_{merge}	0.15	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.61 (at 2.72Å)	Xtriage
Refinement program	PHENIX 1.21rc1_5156	Depositor
R, R_{free}	0.188 , 0.234 0.188 , 0.232	Depositor DCC
R_{free} test set	3174 reflections (4.89%)	wwPDB-VP
Wilson B-factor (Å^2)	71.1	Xtriage
Anisotropy	0.173	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 44.9	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	29137	wwPDB-VP
Average B, all atoms (Å^2)	90.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.73% 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: FE, A1BHL

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	0.55	0/3786	0.68	1/5106 (0.0%)
1	B	0.49	1/3628 (0.0%)	0.65	0/4895
1	C	0.57	1/3599 (0.0%)	0.70	1/4858 (0.0%)
1	D	0.54	0/3788	0.68	1/5107 (0.0%)
All	All	0.54	2/14801 (0.0%)	0.68	3/19966 (0.0%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	230	LYS	CE-NZ	-9.89	1.24	1.49
1	B	320	CYS	CB-SG	-5.07	1.73	1.81

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	C	230	LYS	CD-CE-NZ	-7.39	94.70	111.70
1	A	406	LYS	CD-CE-NZ	6.31	126.22	111.70
1	D	264	ASP	CB-CG-OD2	5.15	122.94	118.30

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	3701	3668	3664	97	0
1	B	3546	3511	3509	74	1
1	C	3515	3491	3490	103	1
1	D	3703	3672	3668	88	2
2	A	38	25	0	1	0
2	B	76	50	0	4	0
2	C	38	25	0	3	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
4	A	26	0	0	3	0
4	B	14	0	0	2	0
4	C	14	0	0	2	0
4	D	20	0	0	7	0
All	All	14695	14442	14331	347	2

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 12.

The worst 5 of 347 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:D:292:GLU:OE1	4:D:801:HOH:O	1.71	1.08
1:C:245:ILE:HD12	1:C:250:ILE:HD11	1.42	0.98
1:D:264:ASP:OD1	1:D:290:ARG:NH2	2.02	0.92
1:B:339:ARG:NH1	1:B:350:CYS:SG	2.43	0.91
1:C:487:VAL:O	1:C:489:LEU:HD22	1.71	0.89

All (2) 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)
1:C:342:GLU:OE2	1:D:559:ARG:HH12[1_565]	1.54	0.06
1:B:576:ARG:HH11	1:D:464:GLY:O[1_655]	1.56	0.04

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	445/516 (86%)	427 (96%)	14 (3%)	4 (1%)	14	34
1	B	431/516 (84%)	413 (96%)	15 (4%)	3 (1%)	19	40
1	C	428/516 (83%)	402 (94%)	21 (5%)	5 (1%)	11	26
1	D	444/516 (86%)	422 (95%)	17 (4%)	5 (1%)	12	28
All	All	1748/2064 (85%)	1664 (95%)	67 (4%)	17 (1%)	13	31

5 of 17 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	112	MET
1	A	305	ARG
1	A	506	ASP
1	D	345	ASN
1	D	478	LYS

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	401/461 (87%)	393 (98%)	8 (2%)	50	76
1	B	385/461 (84%)	374 (97%)	11 (3%)	37	65
1	C	381/461 (83%)	369 (97%)	12 (3%)	35	63
1	D	401/461 (87%)	389 (97%)	12 (3%)	36	64
All	All	1568/1844 (85%)	1525 (97%)	43 (3%)	40	68

5 of 43 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	559	ARG
1	D	346	GLU
1	C	566	ARG
1	D	164	ARG
1	D	408	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 9 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	125	HIS
1	D	364	HIS
1	B	465	GLN
1	C	235	GLN
1	C	567	GLN

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 8 ligands modelled in this entry, 4 are monoatomic - leaving 4 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	$\#\|Z\|>2$
2	A1BHL	B	802	-	37,41,41	0.72	2 (5%)	45,57,57	0.64	1 (2%)
2	A1BHL	A	801	-	37,41,41	0.73	2 (5%)	45,57,57	0.74	2 (4%)
2	A1BHL	B	801	-	37,41,41	0.72	2 (5%)	45,57,57	0.91	1 (2%)
2	A1BHL	C	801	-	37,41,41	0.75	2 (5%)	45,57,57	0.68	1 (2%)

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	A1BHL	B	802	-	-	9/18/20/20	0/4/4/4
2	A1BHL	A	801	-	-	4/18/20/20	0/4/4/4
2	A1BHL	B	801	-	-	10/18/20/20	0/4/4/4
2	A1BHL	C	801	-	-	9/18/20/20	0/4/4/4

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	801	A1BHL	C2-C1	-2.46	1.42	1.47
2	B	802	A1BHL	C2-C1	-2.41	1.42	1.47
2	A	801	A1BHL	C2-C1	-2.32	1.42	1.47
2	C	801	A1BHL	C2-C1	-2.30	1.42	1.47
2	C	801	A1BHL	C3-N1	-2.23	1.31	1.34

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	801	A1BHL	C14-C15-C16	2.54	120.68	118.49
2	A	801	A1BHL	C14-C15-C16	2.49	120.64	118.49
2	C	801	A1BHL	C14-C15-C16	2.17	120.37	118.49
2	B	802	A1BHL	O1-C1-C2	2.08	128.44	124.32
2	A	801	A1BHL	O1-C1-C2	2.06	128.41	124.32

There are no chirality outliers.

5 of 32 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	802	A1BHL	N4-C13-C14-C15
2	B	802	A1BHL	O4-C13-C14-C15

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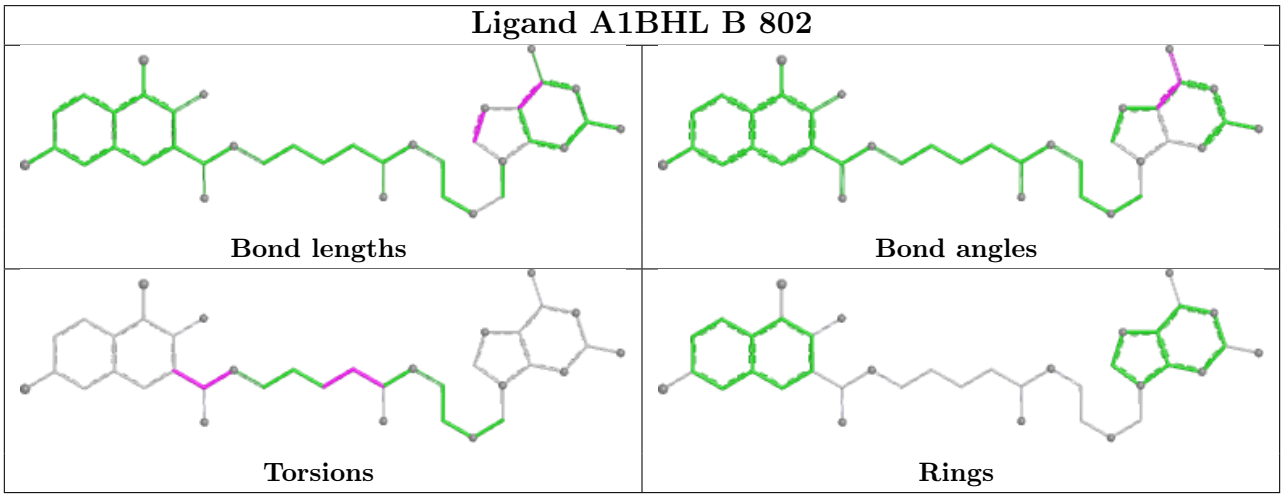
Mol	Chain	Res	Type	Atoms
2	C	801	A1BHL	N4-C13-C14-C15
2	C	801	A1BHL	O4-C13-C14-C15
2	A	801	A1BHL	C11-C10-C9-C8

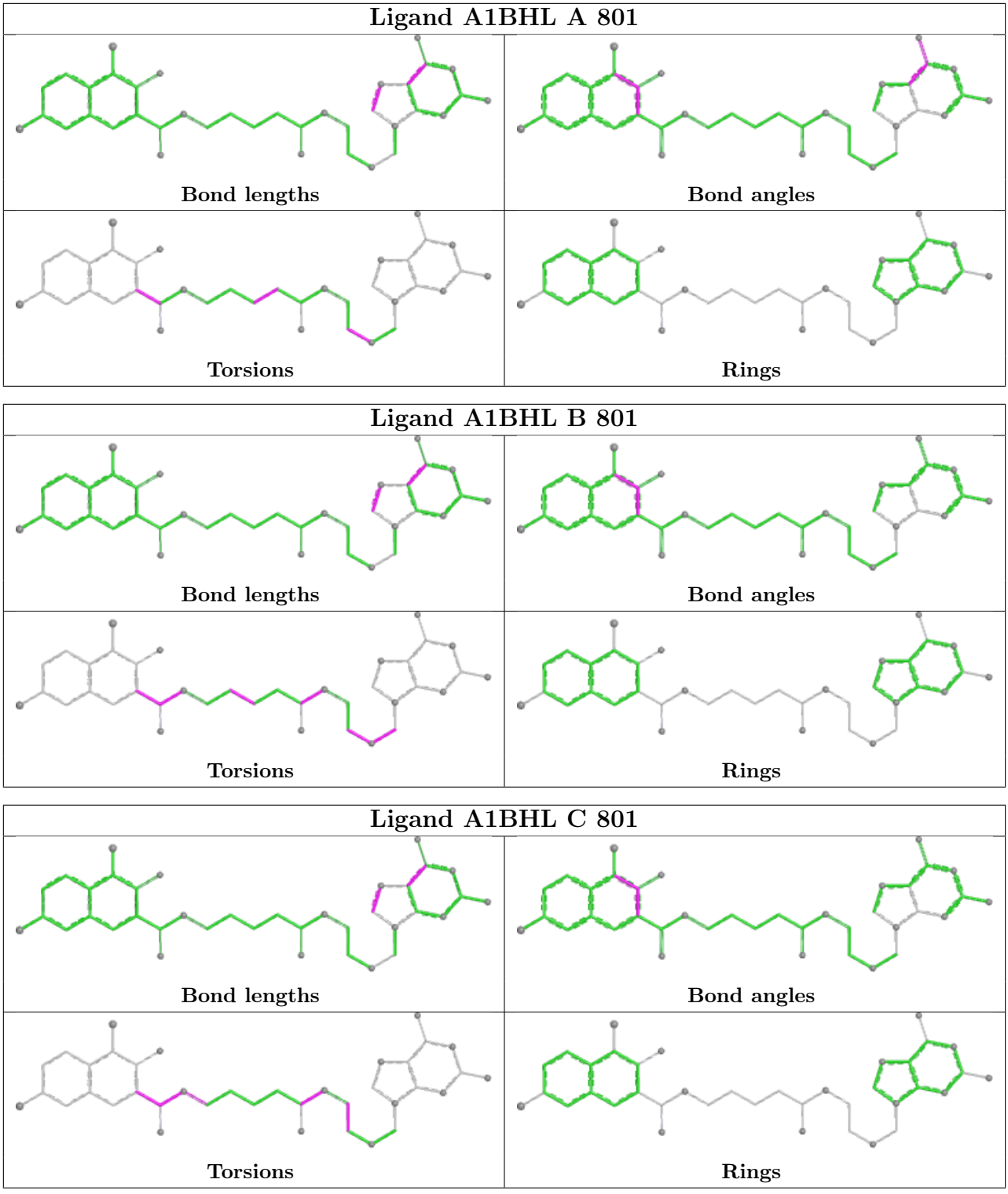
There are no ring outliers.

3 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	802	A1BHL	4	0
2	A	801	A1BHL	1	0
2	C	801	A1BHL	3	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.





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, 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	453/516 (87%)	-0.70	3 (0%)	84	84	48, 79, 134, 168	0
1	B	435/516 (84%)	-0.56	1 (0%)	92	91	52, 92, 148, 174	0
1	C	430/516 (83%)	-0.57	2 (0%)	87	87	50, 85, 145, 181	0
1	D	452/516 (87%)	-0.66	2 (0%)	89	88	50, 80, 146, 177	0
All	All	1770/2064 (85%)	-0.63	8 (0%)	87	87	48, 84, 145, 181	0

The worst 5 of 8 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	507	TYR	3.2
1	D	515	ILE	3.0
1	C	545	PHE	2.5
1	A	276	LEU	2.3
1	A	545	PHE	2.2

6.2 Non-standard residues in protein, DNA, RNA chains

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

6.3 Carbohydrates

There are no monosaccharides in this entry.

6.4 Ligands

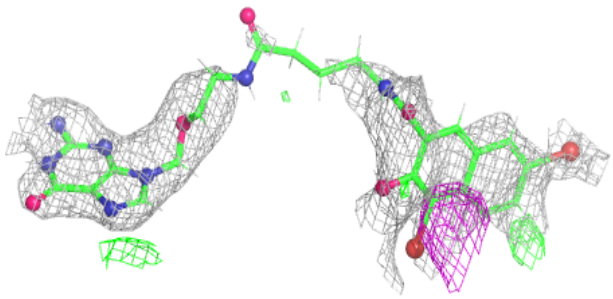
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9'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

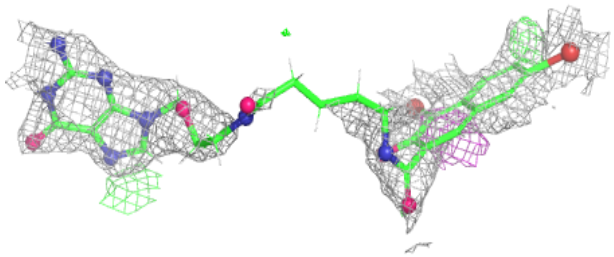
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	A1BHL	B	802	38/38	0.68	0.12	74,130,193,222	0
2	A1BHL	B	801	38/38	0.71	0.14	84,133,231,250	0
2	A1BHL	A	801	38/38	0.76	0.13	55,129,185,239	0
2	A1BHL	C	801	38/38	0.83	0.12	60,121,199,212	0
3	FE	D	701	1/1	0.87	0.08	46,46,46,46	0
3	FE	A	802	1/1	0.93	0.06	49,49,49,49	0
3	FE	C	802	1/1	0.98	0.04	45,45,45,45	0
3	FE	B	803	1/1	0.99	0.05	52,52,52,52	0

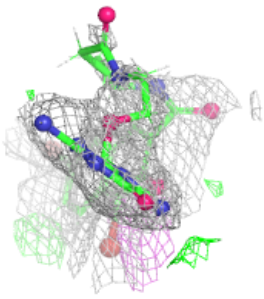
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around A1BHL B 802:

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

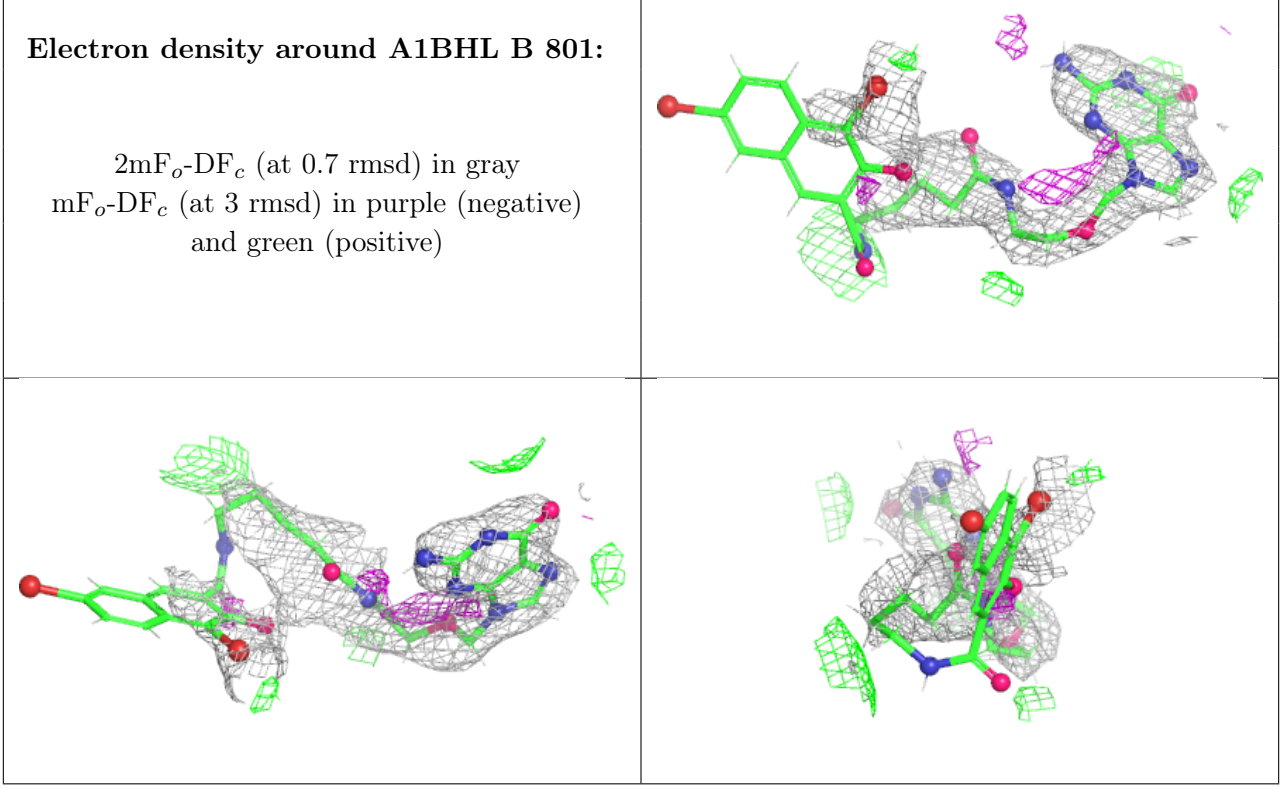






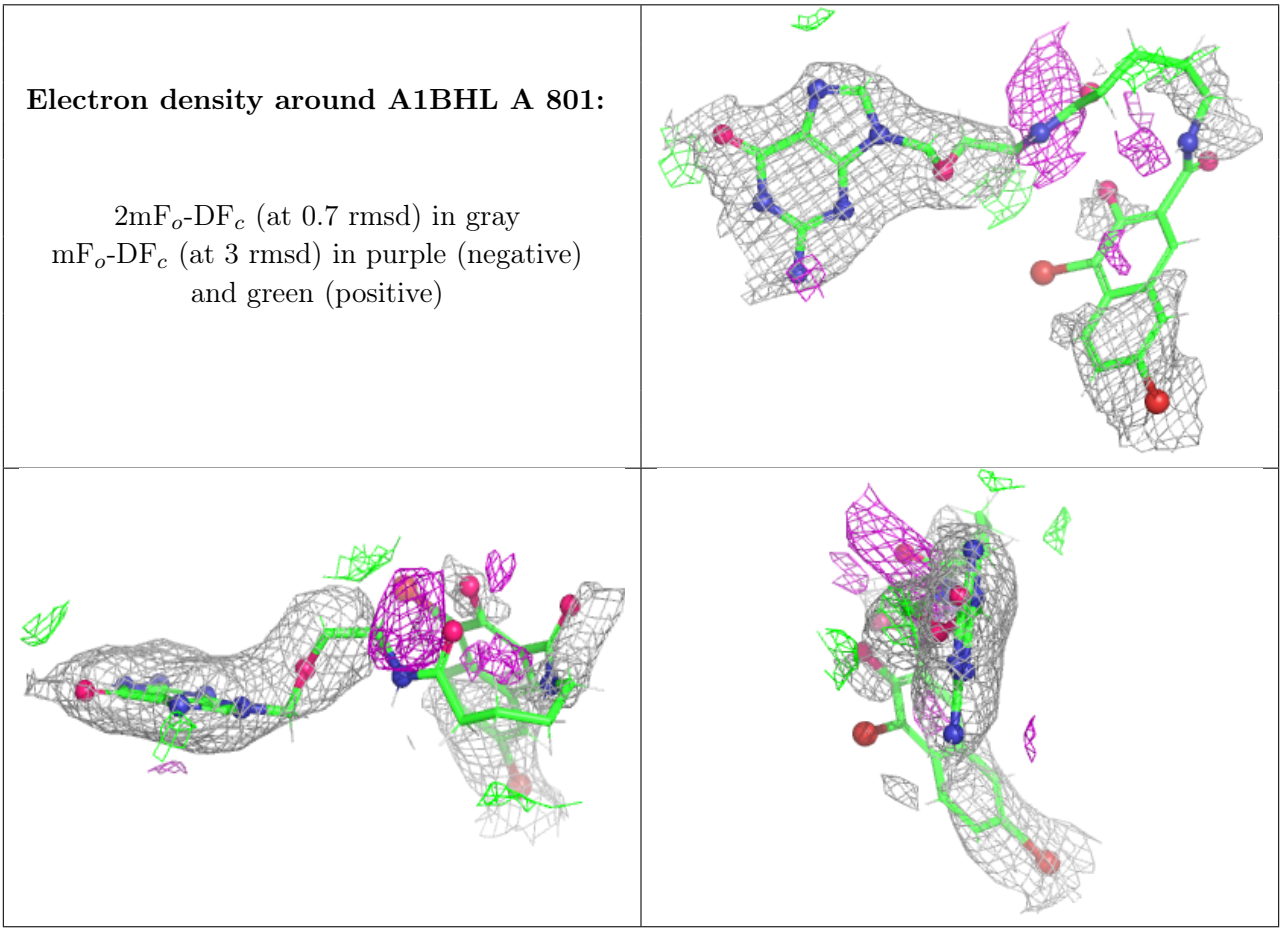
Electron density around A1BHL B 801:

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



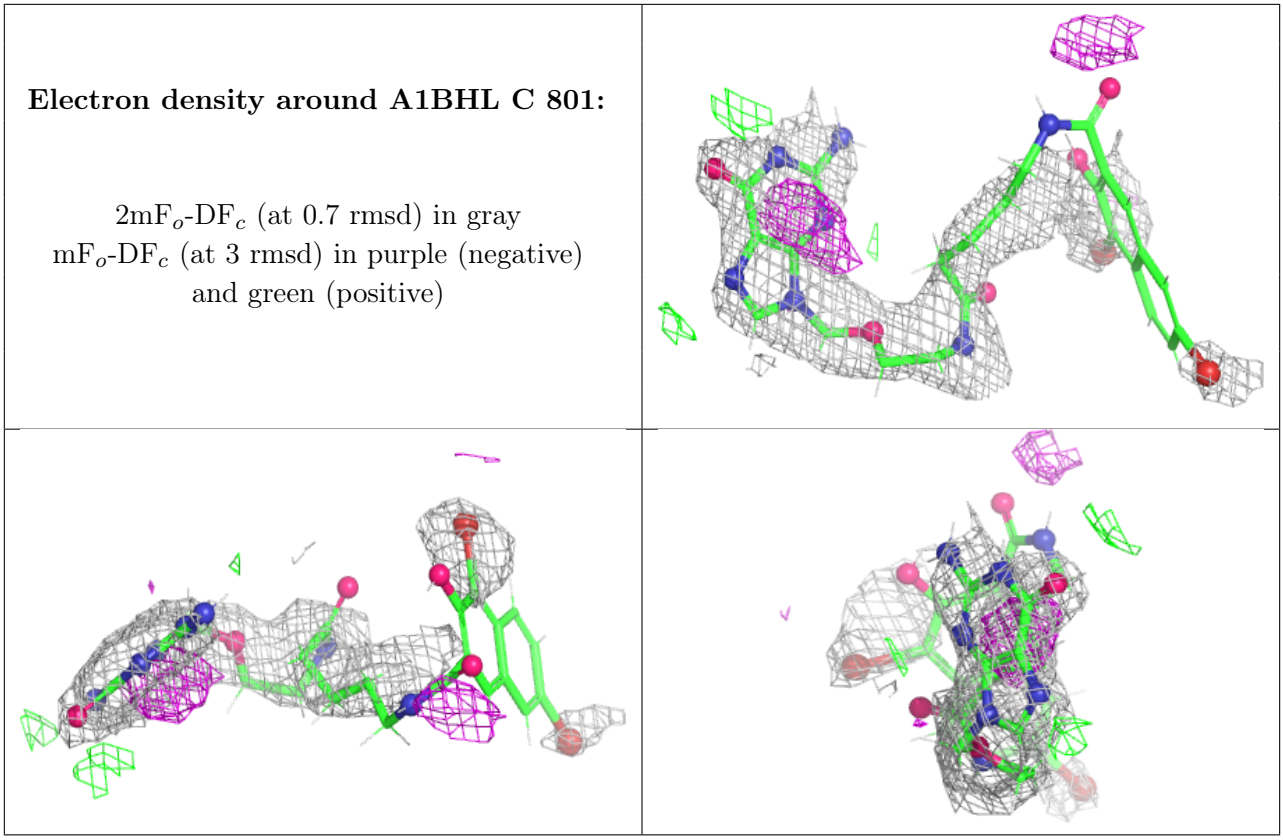
Electron density around A1BHL A 801:

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



Electron density around A1BHL C 801:

$2mF_o$-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.