



Full wwPDB X-ray Structure Validation Report ⓘ

May 24, 2020 – 10:46 pm BST

PDB ID : 4U7O
Title : Active histidine kinase bound with ATP
Authors : Cai, Y.; Hu, X.; Sang, J.
Deposited on : 2014-07-31
Resolution : 2.40 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 following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
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)	:	2.11

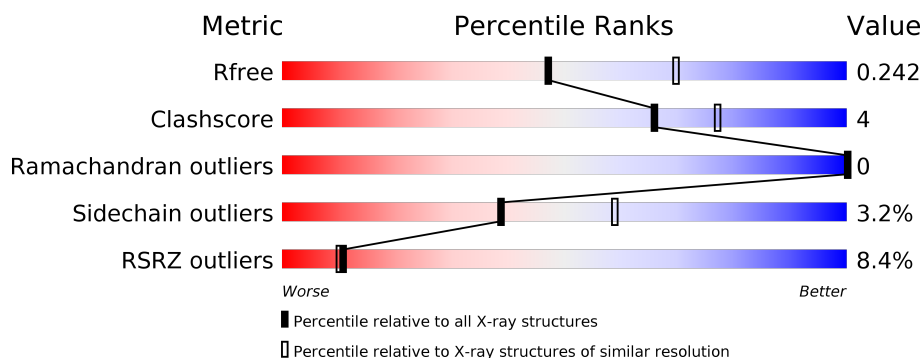
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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	3907 (2.40-2.40)
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)
RSRZ outliers	127900	3811 (2.40-2.40)

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 on 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	277	<div> <div>6%</div> <div> <div></div> <div>75%</div> <div>8%</div> <div>16%</div> </div> </div>
1	B	277	<div> <div>8%</div> <div> <div></div> <div>67%</div> <div>12%</div> <div>21%</div> </div> </div>

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 3716 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 Histidine protein kinase sensor protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	234	Total	C	N	O	S	0	0	0
			1879	1185	322	363	9			
1	B	218	Total	C	N	O	S	0	0	0
			1749	1110	298	333	8			

There are 40 discrepancies between the modelled and reference sequences:

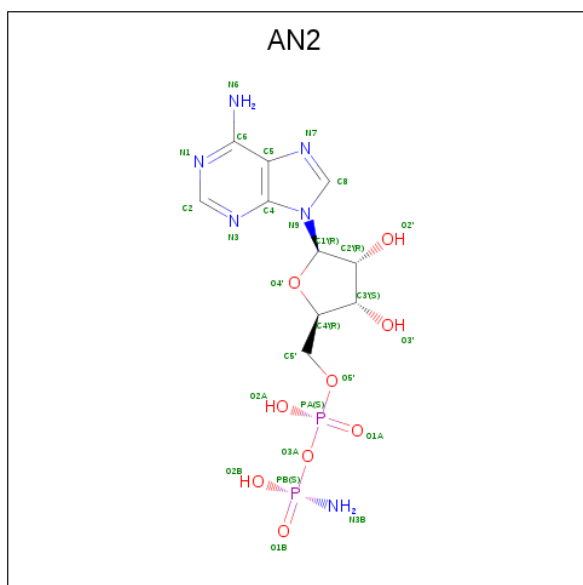
Chain	Residue	Modelled	Actual	Comment	Reference
A	348	MET	-	expression tag	UNP C6VIM1
A	349	GLY	-	expression tag	UNP C6VIM1
A	350	SER	-	expression tag	UNP C6VIM1
A	351	SER	-	expression tag	UNP C6VIM1
A	352	HIS	-	expression tag	UNP C6VIM1
A	353	HIS	-	expression tag	UNP C6VIM1
A	354	HIS	-	expression tag	UNP C6VIM1
A	355	HIS	-	expression tag	UNP C6VIM1
A	356	HIS	-	expression tag	UNP C6VIM1
A	357	HIS	-	expression tag	UNP C6VIM1
A	358	SER	-	expression tag	UNP C6VIM1
A	361	LEU	-	expression tag	UNP C6VIM1
A	362	VAL	-	expression tag	UNP C6VIM1
A	363	PRO	-	expression tag	UNP C6VIM1
A	364	ARG	-	expression tag	UNP C6VIM1
A	365	GLY	-	expression tag	UNP C6VIM1
A	366	SER	-	expression tag	UNP C6VIM1
A	367	ALA	-	expression tag	UNP C6VIM1
A	368	GLU	-	expression tag	UNP C6VIM1
A	369	PHE	-	expression tag	UNP C6VIM1
B	348	MET	-	expression tag	UNP C6VIM1
B	349	GLY	-	expression tag	UNP C6VIM1
B	350	SER	-	expression tag	UNP C6VIM1
B	351	SER	-	expression tag	UNP C6VIM1
B	352	HIS	-	expression tag	UNP C6VIM1

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Chain	Residue	Modelled	Actual	Comment	Reference
B	353	HIS	-	expression tag	UNP C6VIM1
B	354	HIS	-	expression tag	UNP C6VIM1
B	355	HIS	-	expression tag	UNP C6VIM1
B	356	HIS	-	expression tag	UNP C6VIM1
B	357	HIS	-	expression tag	UNP C6VIM1
B	358	SER	-	expression tag	UNP C6VIM1
B	361	LEU	-	expression tag	UNP C6VIM1
B	362	VAL	-	expression tag	UNP C6VIM1
B	363	PRO	-	expression tag	UNP C6VIM1
B	364	ARG	-	expression tag	UNP C6VIM1
B	365	GLY	-	expression tag	UNP C6VIM1
B	366	SER	-	expression tag	UNP C6VIM1
B	367	ALA	-	expression tag	UNP C6VIM1
B	368	GLU	-	expression tag	UNP C6VIM1
B	369	PHE	-	expression tag	UNP C6VIM1

- Molecule 2 is AMP PHOSPHORAMIDATE (three-letter code: AN2) (formula: $C_{10}H_{16}N_6O_9P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			27	10	6	9	2		
2	B	1	Total	C	N	O	P	0	0
			27	10	6	9	2		

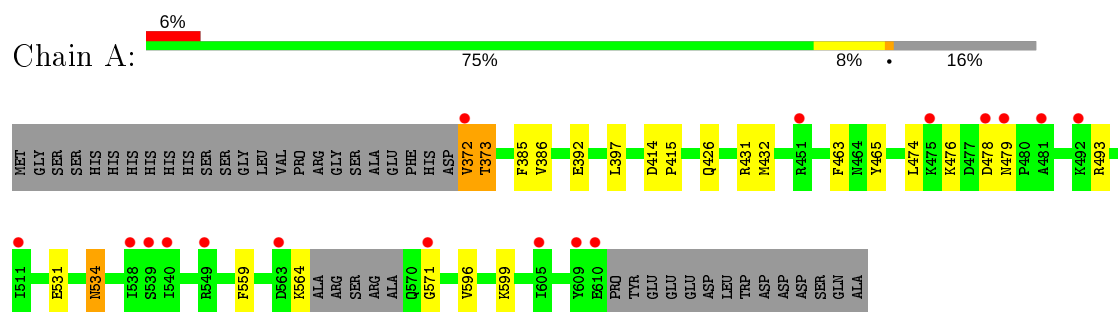
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	18	Total 18	O 18	0	0
3	B	16	Total 16	O 16	0	0

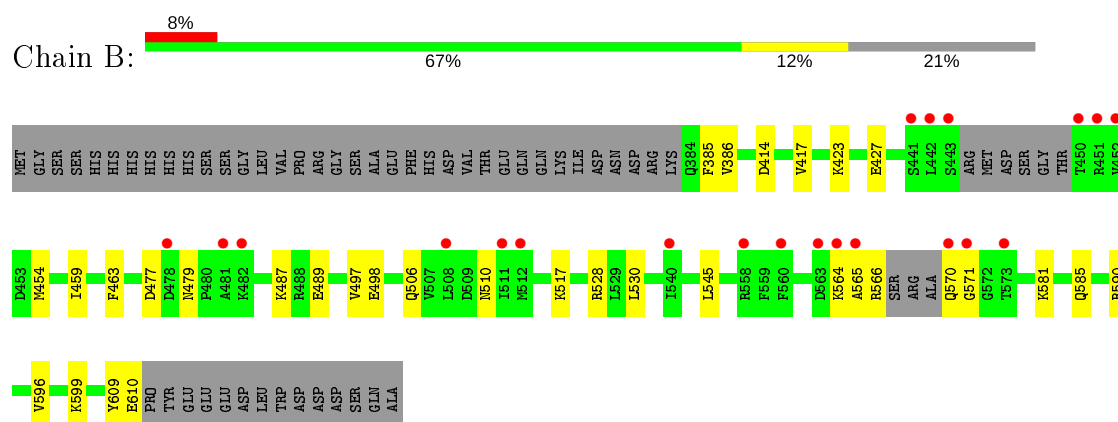
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: Histidine protein kinase sensor protein



- Molecule 1: Histidine protein kinase sensor protein



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	54.53Å 98.39Å 116.37Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	13.99 – 2.40 24.84 – 2.39	Depositor EDS
% Data completeness (in resolution range)	99.2 (13.99-2.40) 99.2 (24.84-2.39)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.61 (at 2.39Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.4_1496)	Depositor
R, R_{free}	0.198 , 0.239 0.209 , 0.242	Depositor DCC
R_{free} test set	1260 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å ²)	51.4	Xtriage
Anisotropy	0.192	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 45.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	3716	wwPDB-VP
Average B, all atoms (Å ²)	63.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.32% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: AN2

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	0.59	0/1910	0.70	0/2577
1	B	0.50	0/1779	0.67	0/2401
All	All	0.54	0/3689	0.69	0/4978

There are no bond length outliers.

There are no bond angle outliers.

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	1879	0	1869	13	0
1	B	1749	0	1743	18	0
2	A	27	0	13	0	0
2	B	27	0	13	1	0
3	A	18	0	0	1	0
3	B	16	0	0	2	0
All	All	3716	0	3638	29	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 4.

All (29) 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:373:THR:OG1	3:A:817:HOH:O	1.93	0.87
1:B:528:ARG:NH1	3:B:801:HOH:O	2.16	0.78
1:B:506:GLN:O	1:B:510:ASN:ND2	2.24	0.70
1:B:545:LEU:O	3:B:806:HOH:O	2.14	0.66
1:B:564:LYS:HG2	1:B:565:ALA:H	1.72	0.55
1:A:478:ASP:HB2	1:A:479:ASN:O	2.07	0.55
1:B:545:LEU:HD11	1:B:566:ARG:HB2	1.87	0.55
1:B:609:TYR:O	1:B:610:GLU:HG3	2.08	0.54
1:A:534:ASN:OD1	1:A:534:ASN:N	2.41	0.53
1:A:431:ARG:HD2	1:A:571:GLY:HA2	1.90	0.52
1:A:385:PHE:CE2	1:B:386:VAL:HG21	2.45	0.51
1:A:493:ARG:HD3	1:A:531:GLU:OE2	2.11	0.50
1:A:372:VAL:HG23	1:A:373:THR:H	1.77	0.48
1:B:581:LYS:HE2	1:B:585:GLN:NE2	2.28	0.48
1:A:386:VAL:HG13	1:B:385:PHE:CD2	2.50	0.46
1:B:517:LYS:HD2	1:B:571:GLY:HA2	1.98	0.46
1:A:392:GLU:HG3	1:A:559:PHE:CD1	2.51	0.46
1:B:459:ILE:HD11	1:B:497:VAL:HB	1.98	0.45
1:B:596:VAL:HB	1:B:599:LYS:HB3	1.99	0.45
1:B:477:ASP:OD2	1:B:479:ASN:ND2	2.50	0.44
1:B:454:MET:HB3	1:B:498:GLU:HG3	2.00	0.43
1:A:392:GLU:HG3	1:A:559:PHE:CE1	2.53	0.43
1:B:487:LYS:HE2	1:B:489:GLU:OE2	2.19	0.42
1:A:397:LEU:HG	1:A:432:MET:SD	2.59	0.42
1:A:596:VAL:O	1:A:599:LYS:HB3	2.19	0.42
1:B:517:LYS:HZ2	2:B:701:AN2:H3B1	1.66	0.42
1:B:414:ASP:HB3	1:B:417:VAL:HG22	2.01	0.41
1:A:414:ASP:HA	1:A:415:PRO:HD3	1.80	0.41
1:B:423:LYS:HE2	1:B:427:GLU:OE2	2.20	0.40

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	230/277 (83%)	229 (100%)	1 (0%)	0	100	100
1	B	212/277 (76%)	203 (96%)	9 (4%)	0	100	100
All	All	442/554 (80%)	432 (98%)	10 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

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	211/247 (85%)	202 (96%)	9 (4%)	29	46
1	B	195/247 (79%)	191 (98%)	4 (2%)	53	72
All	All	406/494 (82%)	393 (97%)	13 (3%)	39	59

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	372	VAL
1	A	373	THR
1	A	426	GLN
1	A	463	PHE
1	A	465	TYR
1	A	474	LEU
1	A	476	LYS
1	A	534	ASN
1	A	564	LYS
1	B	463	PHE
1	B	530	LEU
1	B	570	GLN
1	B	590	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

5.6 Ligand geometry ⓘ

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	AN2	B	701	-	24,29,29	4.63	9 (37%)	25,45,45	1.65	2 (8%)
2	AN2	A	701	-	24,29,29	4.80	9 (37%)	25,45,45	1.64	4 (16%)

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	AN2	B	701	-	-	1/9/32/32	0/3/3/3
2	AN2	A	701	-	-	0/9/32/32	0/3/3/3

All (18) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	701	AN2	O4'-C1'	14.84	1.61	1.41

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	701	AN2	C2'-C1'	-14.70	1.31	1.53
2	B	701	AN2	O4'-C1'	14.37	1.61	1.41
2	B	701	AN2	C2'-C1'	-14.12	1.32	1.53
2	B	701	AN2	O4'-C4'	-6.54	1.30	1.45
2	A	701	AN2	O4'-C4'	-6.21	1.31	1.45
2	A	701	AN2	PB-O1B	4.64	1.53	1.46
2	B	701	AN2	PB-O1B	3.56	1.51	1.46
2	A	701	AN2	C2-N3	3.34	1.37	1.32
2	A	701	AN2	PB-O2B	-3.29	1.47	1.56
2	B	701	AN2	C2-N3	3.18	1.37	1.32
2	B	701	AN2	O3'-C3'	-3.15	1.35	1.43
2	A	701	AN2	C6-N6	3.10	1.45	1.34
2	A	701	AN2	O3'-C3'	-2.96	1.36	1.43
2	B	701	AN2	C6-N6	2.87	1.44	1.34
2	B	701	AN2	O2'-C2'	2.82	1.49	1.43
2	A	701	AN2	O2'-C2'	2.55	1.49	1.43
2	B	701	AN2	PB-O2B	-2.28	1.50	1.56

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	701	AN2	N3-C2-N1	-6.18	119.01	128.68
2	A	701	AN2	N3-C2-N1	-5.35	120.31	128.68
2	A	701	AN2	C3'-C2'-C1'	3.08	105.62	100.98
2	B	701	AN2	C3'-C2'-C1'	2.88	105.32	100.98
2	A	701	AN2	O2B-PB-O1B	-2.71	103.22	110.25
2	A	701	AN2	PA-O3A-PB	-2.40	124.96	132.56

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	701	AN2	PB-O3A-PA-O2A

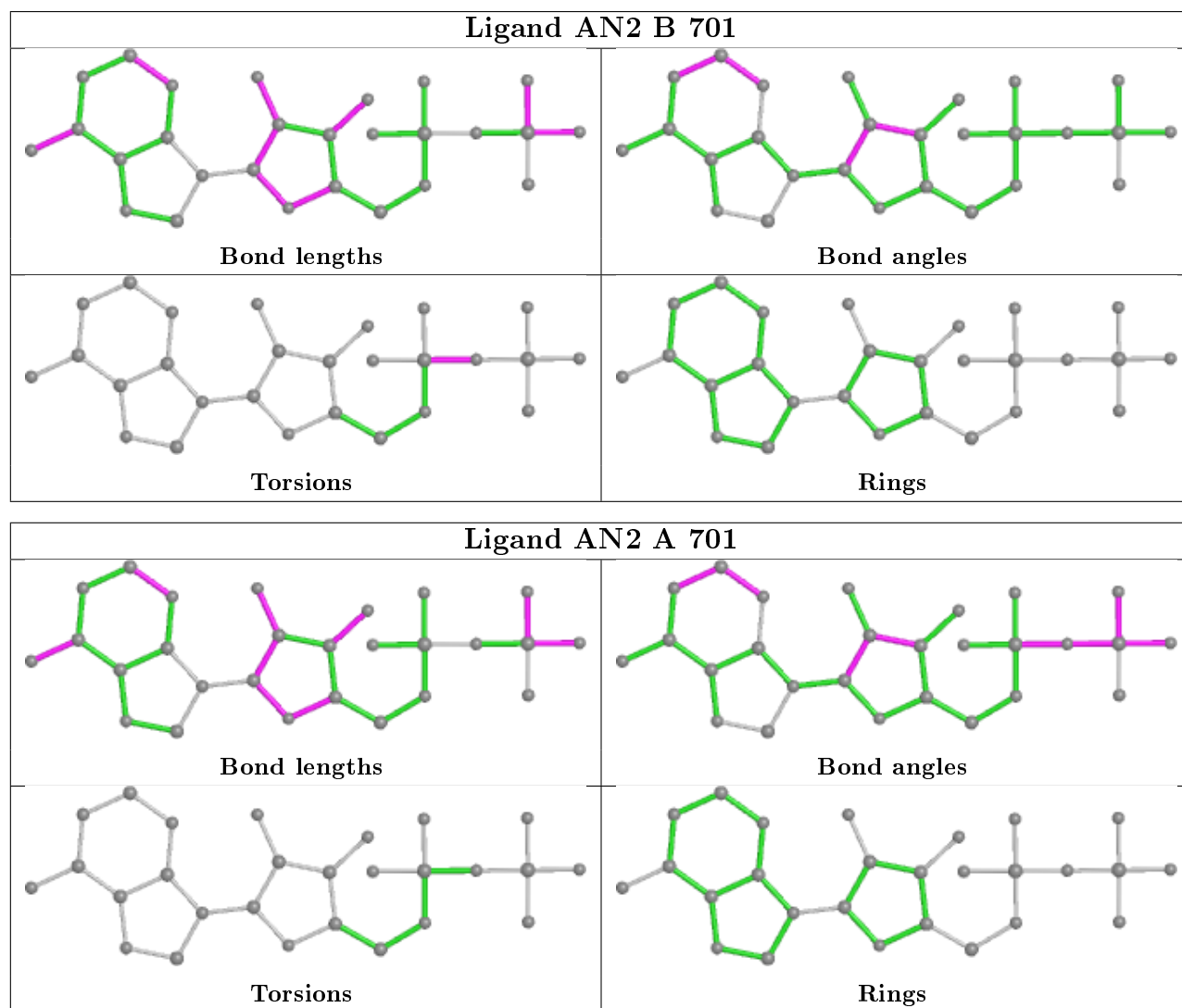
There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	701	AN2	1	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 ⓘ

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, 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	234/277 (84%)	0.34	17 (7%) 15 13	36, 52, 95, 201	0
1	B	218/277 (78%)	0.54	21 (9%) 8 7	43, 61, 115, 193	0
All	All	452/554 (81%)	0.44	38 (8%) 11 10	36, 57, 106, 201	0

All (38) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	372	VAL	11.3
1	B	450	THR	10.8
1	B	451	ARG	5.9
1	B	571	GLY	5.6
1	A	478	ASP	4.8
1	B	511	ILE	4.7
1	A	481	ALA	4.4
1	B	481	ALA	4.3
1	B	565	ALA	4.1
1	A	540	ILE	3.9
1	B	441	SER	3.8
1	A	451	ARG	3.7
1	B	442	LEU	3.6
1	B	478	ASP	3.6
1	A	571	GLY	3.6
1	B	452	VAL	3.4
1	A	563	ASP	3.3
1	B	558	ARG	3.2
1	B	512	MET	3.1
1	A	492	LYS	3.0
1	B	570	GLN	2.8
1	A	479	ASN	2.8
1	A	610	GLU	2.6
1	A	549	ARG	2.5

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Mol	Chain	Res	Type	RSRZ
1	A	511	ILE	2.4
1	B	560	PHE	2.4
1	A	539	SER	2.4
1	B	540	ILE	2.4
1	A	605	ILE	2.4
1	B	563	ASP	2.3
1	B	564	LYS	2.3
1	A	609	TYR	2.3
1	B	443	SER	2.3
1	B	482	LYS	2.3
1	B	573	THR	2.2
1	B	508	LEU	2.2
1	A	538	ILE	2.1
1	A	475	LYS	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 carbohydrates in this entry.

6.4 Ligands [i](#)

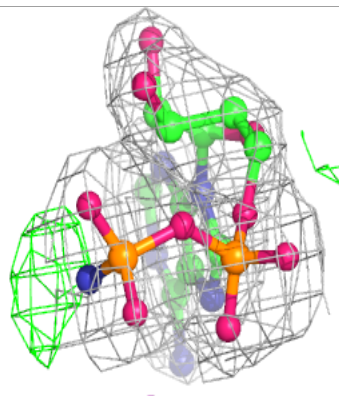
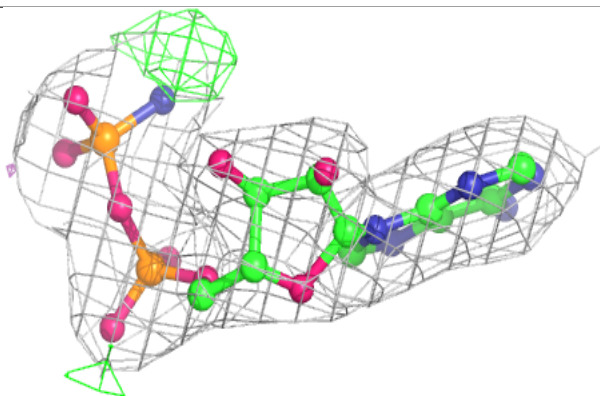
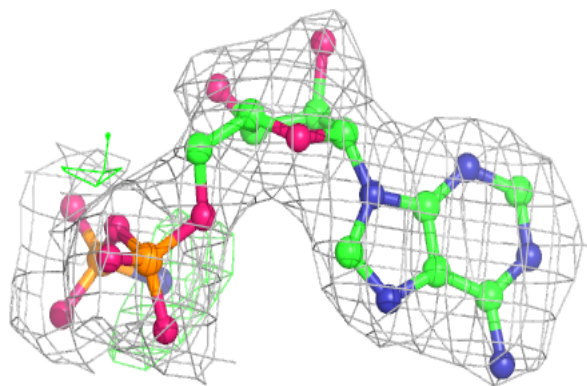
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q<0.9' lists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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
2	AN2	B	701	27/27	0.95	0.12	40,56,74,96	0
2	AN2	A	701	27/27	0.98	0.10	31,43,52,85	0

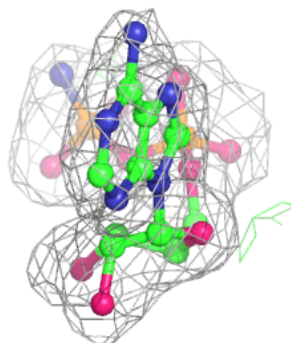
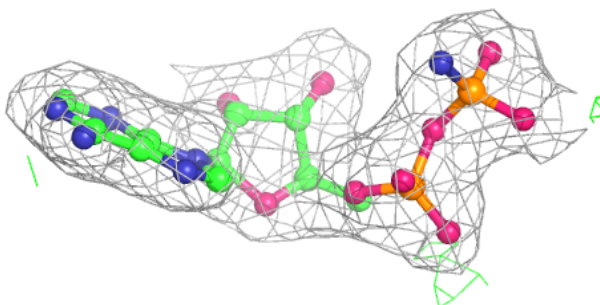
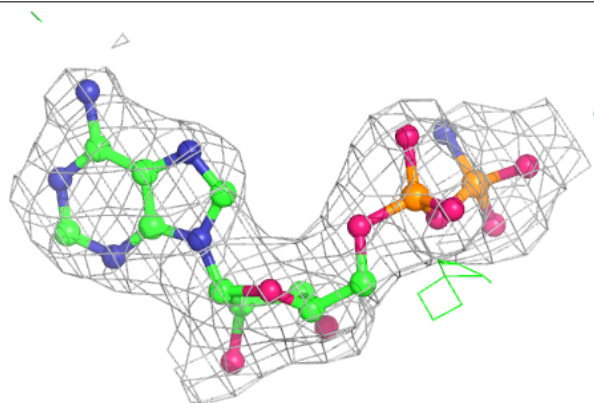
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around AN2 B 701:

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

**Electron density around AN2 A 701:**

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



6.5 Other polymers ⓘ

There are no such residues in this entry.