



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 17, 2026 – 11:05 PM UTC

PDB ID : 9BHI / pdb_00009bhi
Title : Crystal structure of the MerTK kinase domain with SA4488
Authors : Jakob, C.G.; Qui, W.; Jain, R.
Deposited on : 2024-04-20
Resolution : 2.07 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

MolProbity : 4-5-2 with Phenix2.0
Mogul : 2022.3.0, CSD as543be (2022)
Xtriage (Phenix) : 2.0
EDS : 3.0
Buster-report : wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4 : 9.0.010 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

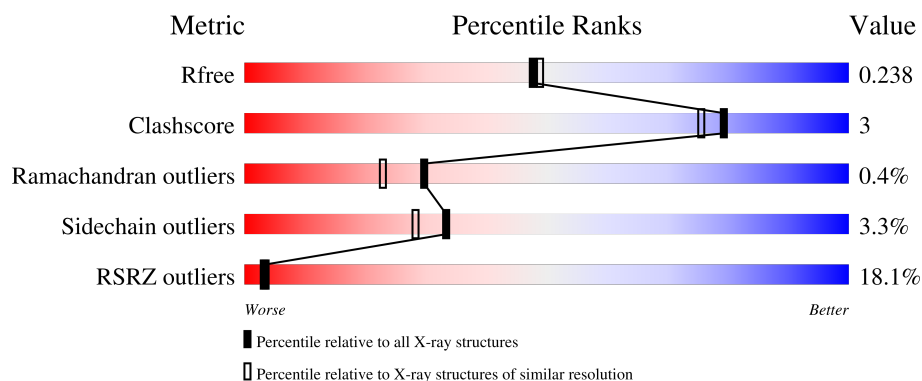
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.07 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	3774 (2.08-2.04)
Clashscore	190562	3883 (2.08-2.04)
Ramachandran outliers	187476	3860 (2.08-2.04)
Sidechain outliers	187428	3860 (2.08-2.04)
RSRZ outliers	180081	3775 (2.08-2.04)

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

Mol	Chain	Length	Quality of chain
1	A	323	16% 78% 9% 13%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 2471 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 Mer tyrosine kinase domain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	282	Total	C	N	O	S	0	0	0
			2223	1433	369	400	21			

There are 28 discrepancies between the modelled and reference sequences:

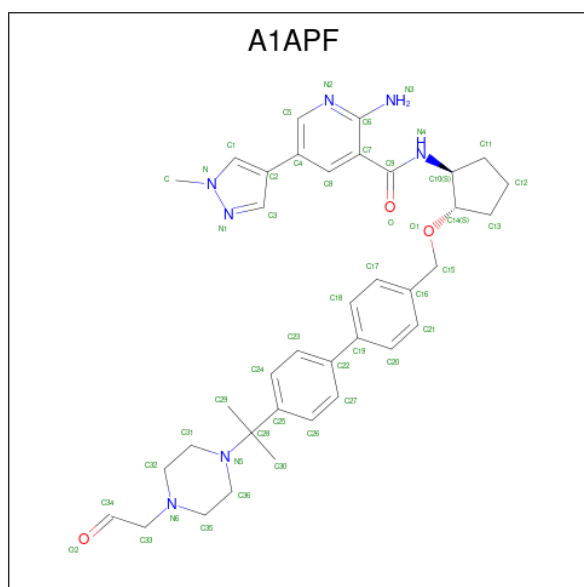
Chain	Residue	Modelled	Actual	Comment	Reference
A	550	MET	-	expression tag	UNP Q12866
A	551	SER	-	expression tag	UNP Q12866
A	552	TYR	-	expression tag	UNP Q12866
A	553	TYR	-	expression tag	UNP Q12866
A	554	HIS	-	expression tag	UNP Q12866
A	555	HIS	-	expression tag	UNP Q12866
A	556	HIS	-	expression tag	UNP Q12866
A	557	HIS	-	expression tag	UNP Q12866
A	558	HIS	-	expression tag	UNP Q12866
A	559	HIS	-	expression tag	UNP Q12866
A	560	ASP	-	expression tag	UNP Q12866
A	561	TYR	-	expression tag	UNP Q12866
A	562	ASP	-	expression tag	UNP Q12866
A	563	ILE	-	expression tag	UNP Q12866
A	564	PRO	-	expression tag	UNP Q12866
A	565	THR	-	expression tag	UNP Q12866
A	566	THR	-	expression tag	UNP Q12866
A	567	GLU	-	expression tag	UNP Q12866
A	568	ASN	-	expression tag	UNP Q12866
A	569	LEU	-	expression tag	UNP Q12866
A	570	TYR	-	expression tag	UNP Q12866
A	571	PHE	-	expression tag	UNP Q12866
A	572	GLN	-	expression tag	UNP Q12866
A	573	GLY	-	expression tag	UNP Q12866
A	574	ALA	-	expression tag	UNP Q12866
A	575	MET	-	expression tag	UNP Q12866
A	576	ASP	-	expression tag	UNP Q12866

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Chain	Residue	Modelled	Actual	Comment	Reference
A	577	PRO	-	expression tag	UNP Q12866

- Molecule 2 is (5P)-2-amino-5-(1-methyl-1H-pyrazol-4-yl)-N-[(1R,2S)-2-[(4'-{2-[4-(2-oxoethyl)piperazin-1-yl]propan-2-yl}[1,1'-biphenyl]-4-yl)methoxy]cyclopentyl}pyridine-3-carboxamide (CCD ID: A1APF) (formula: C₃₇H₄₅N₇O₃) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			47	37	7	3		

- Molecule 3 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	2	Total	Cl	0	0
			2	2		

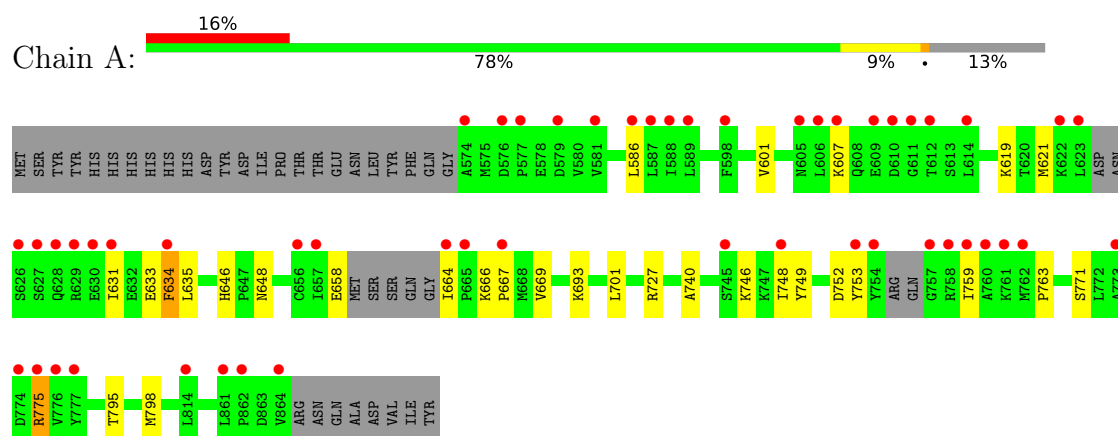
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	199	Total	O	0	0
			199	199		

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: Mer tyrosine kinase domain



4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, α , β , γ	79.56Å 79.56Å 135.42Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	68.59 – 2.07 68.59 – 2.07	Depositor EDS
% Data completeness (in resolution range)	100.0 (68.59-2.07) 100.0 (68.59-2.07)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.37 (at 2.07Å)	Xtriage
Refinement program	BUSTER 2.11.8	Depositor
R, R_{free}	0.210 , 0.230 0.205 , 0.238	Depositor DCC
R_{free} test set	1368 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	39.7	Xtriage
Anisotropy	0.381	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 59.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	2471	wwPDB-VP
Average B, all atoms (Å ²)	47.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.03% 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: CL, A1APF

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	0.73	1/2270 (0.0%)	1.01	5/3070 (0.2%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	740	ALA	CA-C	5.60	1.59	1.53

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	634	PHE	CA-CB-CG	6.66	120.46	113.80
1	A	752	ASP	CA-C-N	6.36	133.69	121.54
1	A	752	ASP	C-N-CA	6.36	133.69	121.54
1	A	633	GLU	CA-C-N	5.04	127.03	120.28
1	A	633	GLU	C-N-CA	5.04	127.03	120.28

There are no chirality outliers.

There are no planarity outliers.

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	A	2223	0	2215	12	0
2	A	47	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	2	0	0	0	0
4	A	199	0	0	0	0
All	All	2471	0	2215	12	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 3.

All (12) 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:727:ARG:NH2	1:A:763:PRO:HG3	2.05	0.71
1:A:586:LEU:HA	1:A:607:LYS:HD3	1.85	0.58
1:A:658:GLU:HB2	1:A:666:LYS:HB3	1.88	0.54
1:A:646:HIS:HD2	1:A:648:ASN:H	1.58	0.51
1:A:646:HIS:CD2	1:A:648:ASN:H	2.33	0.46
1:A:775:ARG:HA	1:A:775:ARG:HD3	1.76	0.44
1:A:795:THR:HB	1:A:798:MET:HE3	2.00	0.43
1:A:771:SER:O	1:A:775:ARG:HA	2.19	0.42
1:A:634:PHE:CE1	1:A:667:PRO:HB2	2.56	0.41
1:A:601:VAL:HG22	1:A:619:LYS:HG2	2.01	0.41
1:A:631:ILE:O	1:A:635:LEU:HG	2.21	0.40
1:A:748:ILE:O	1:A:749:TYR:HB2	2.22	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	274/323 (85%)	266 (97%)	7 (3%)	1 (0%)	30 23

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	753	TYR

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	240/290 (83%)	232 (97%)	8 (3%)	33	28

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	621	MET
1	A	664	ILE
1	A	669	VAL
1	A	693	LYS
1	A	701	LEU
1	A	746	LYS
1	A	759	ILE
1	A	775	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	646	HIS
1	A	648	ASN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 3 ligands modelled in this entry, 2 are monoatomic - leaving 1 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	A1APF	A	901	-	51,52,52	1.06	6 (11%)	63,74,74	0.69	2 (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
2	A1APF	A	901	-	-	1/35/56/56	0/6/6/6

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	901	A1APF	C29-C28	-3.89	1.48	1.53
2	A	901	A1APF	C28-N5	3.27	1.55	1.47
2	A	901	A1APF	C36-N5	2.90	1.51	1.47
2	A	901	A1APF	C30-C28	-2.60	1.50	1.53
2	A	901	A1APF	C31-N5	2.54	1.50	1.47
2	A	901	A1APF	C33-N6	2.05	1.51	1.47

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	901	A1APF	C36-N5-C31	2.47	112.21	109.09
2	A	901	A1APF	C29-C28-C25	-2.34	104.22	110.52

There are no chirality outliers.

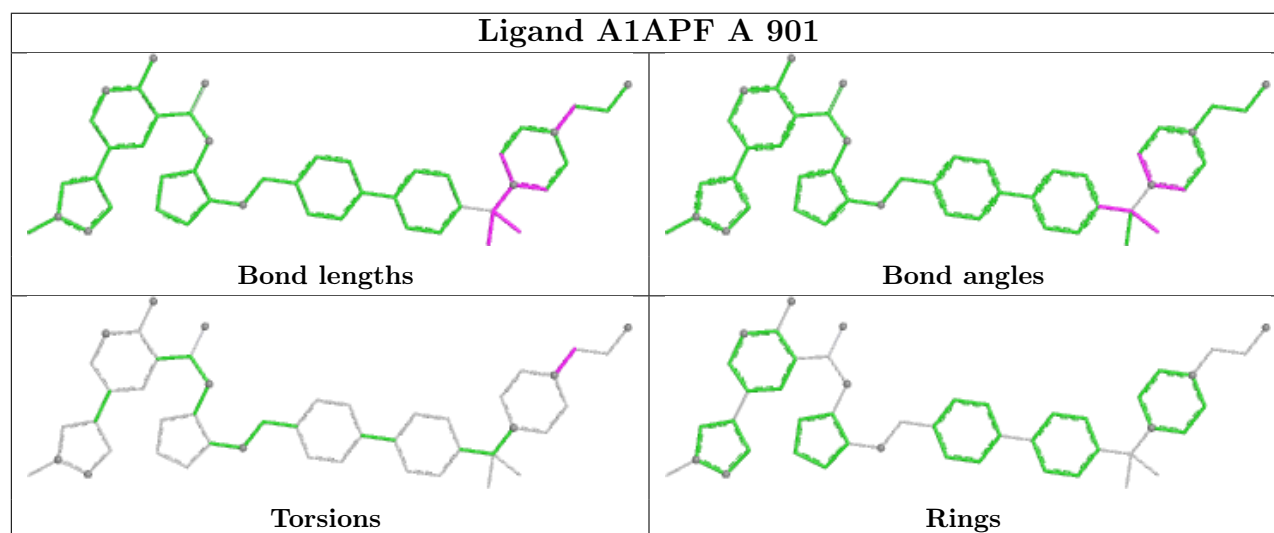
All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	901	A1APF	C34-C33-N6-C35

There are no ring outliers.

No monomer is involved in short contacts.

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



5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

In the following table, the column labelled ‘#RSRZ > 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q < 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å ²)	Q<0.9
1	A	282/323 (87%)	0.99	51 (18%) 3 3	27, 44, 77, 84	0

All (51) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	753	TYR	6.0
1	A	634	PHE	5.6
1	A	754	TYR	5.1
1	A	664	ILE	5.0
1	A	626	SER	4.9
1	A	864	VAL	4.6
1	A	773	ALA	4.5
1	A	762	MET	4.4
1	A	612	THR	4.2
1	A	777	TYR	4.1
1	A	775	ARG	4.0
1	A	774	ASP	4.0
1	A	576	ASP	4.0
1	A	623	LEU	4.0
1	A	759	ILE	3.7
1	A	629	ARG	3.7
1	A	758	ARG	3.7
1	A	630	GLU	3.5
1	A	628	GLN	3.3
1	A	605	ASN	3.3
1	A	776	VAL	3.2
1	A	757	GLY	3.2
1	A	748	ILE	3.2
1	A	631	ILE	3.1
1	A	598	PHE	3.0
1	A	760	ALA	3.0
1	A	606	LEU	3.0

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Mol	Chain	Res	Type	RSRZ
1	A	614	LEU	2.7
1	A	588	ILE	2.7
1	A	589	LEU	2.7
1	A	861	LEU	2.7
1	A	745	SER	2.7
1	A	761	LYS	2.6
1	A	610	ASP	2.5
1	A	665	PRO	2.5
1	A	814	LEU	2.5
1	A	586	LEU	2.4
1	A	607	LYS	2.4
1	A	657	ILE	2.3
1	A	611	GLY	2.3
1	A	587	LEU	2.2
1	A	577	PRO	2.2
1	A	862	PRO	2.2
1	A	667	PRO	2.1
1	A	622	LYS	2.1
1	A	579	ASP	2.1
1	A	627	SER	2.1
1	A	656	CYS	2.1
1	A	581	VAL	2.1
1	A	574	ALA	2.1
1	A	609	GLU	2.0

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

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

6.3 Carbohydrates [i](#)

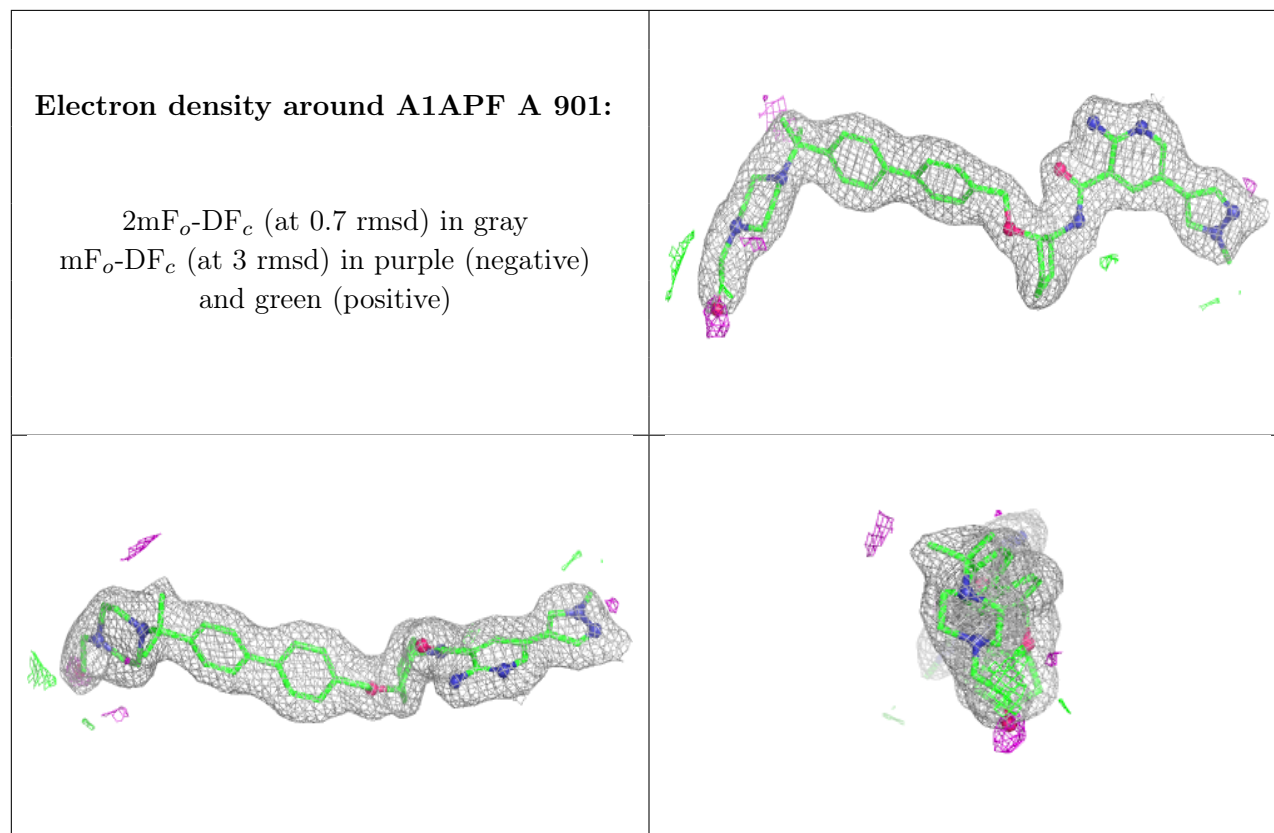
There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	A1APF	A	901	47/47	0.94	0.10	35,37,46,50	0
3	CL	A	902	1/1	0.99	0.07	39,39,39,39	0
3	CL	A	903	1/1	1.00	0.01	32,32,32,32	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.



6.5 Other polymers [i](#)

There are no such residues in this entry.