Full wwPDB X-ray Structure Validation Report (i)

Nov 5, 2024 – 12:30 pm GMT

PDB ID	:	8R2K
Title	:	Human Carbonic Anhydrase II in complex with 4-((2-oxo-5-(3,4,5-trimethoxy phenyl)-2,5-dihydrofuran-3-yl)amino)benzenesulfonamide
Authors	:	Angeli, A.; Ferraroni, M.
Deposited on	:	2023-11-06
Resolution	:	1.60 Å(reported)

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

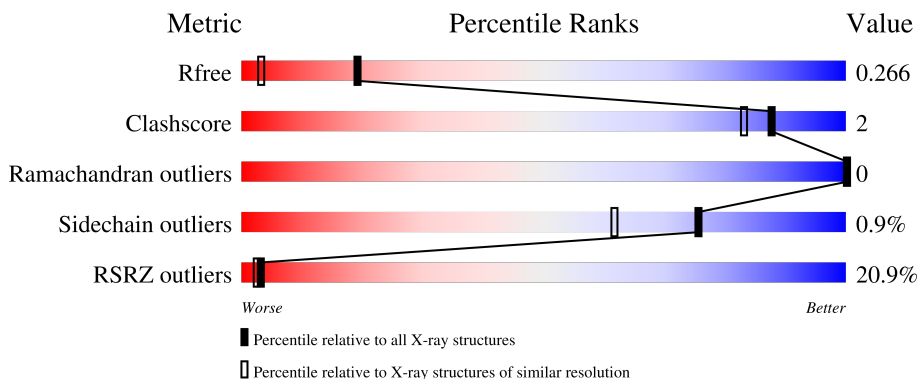|		
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.003 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.39

1 Overall quality at a glance ⓘ

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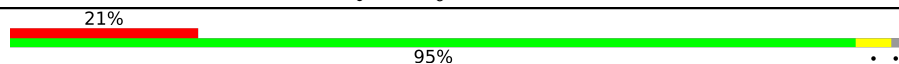*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.60 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	Percentile Ranks	Value
Rfree		0.266
Clashscore		2
Ramachandran outliers		0
Sidechain outliers		0.9%
RSRZ outliers		20.9%

Worse — *Better*

▮ Percentile relative to all X-ray structures
▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	4274 (1.60-1.60)
Clashscore	180529	4682 (1.60-1.60)
Ramachandran outliers	177936	4583 (1.60-1.60)
Sidechain outliers	177891	4582 (1.60-1.60)
RSRZ outliers	164620	4272 (1.60-1.60)

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	AAA	260	21% / 95%

2 Entry composition (i)

There are 5 unique types of molecules in this entry. The entry contains 2308 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 Carbonic anhydrase 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	AAA	258	Total 2079	C 1337	N 353	O 387	S 2	0	15	0

- Molecule 2 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	AAA	1	Total 6	C 3	O 3	0	0

- Molecule 3 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	AAA	1	Total 1	Zn 1	0	0

- Molecule 4 is 4-[[(2 {R})-5-oxidanylidene-2-(2,4,5-trimethoxyphenyl)-2 {H}-furan-4-yl]amin

o]benzenesulfonamide (three-letter code: XPI) (formula: $C_{19}H_{20}N_2O_7S$) (labeled as "Ligand of Interest" by depositor).
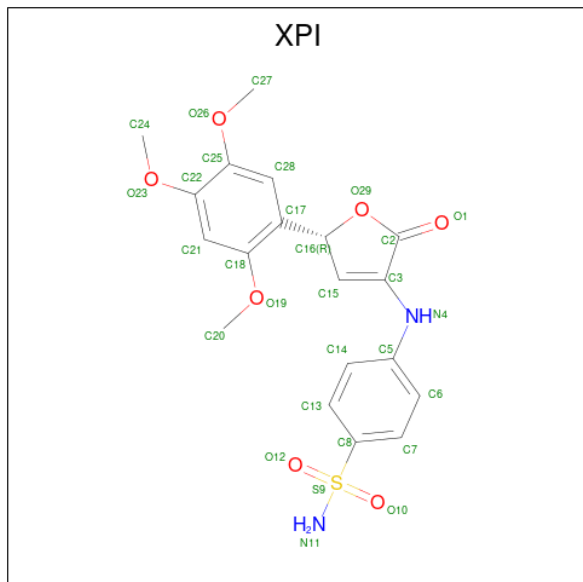
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	S		
4	AAA	1	29	19	2	7	1	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
5	AAA	193	193	193	0	0

3 Residue-property plots ⓘ

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: Carbonic anhydrase 2
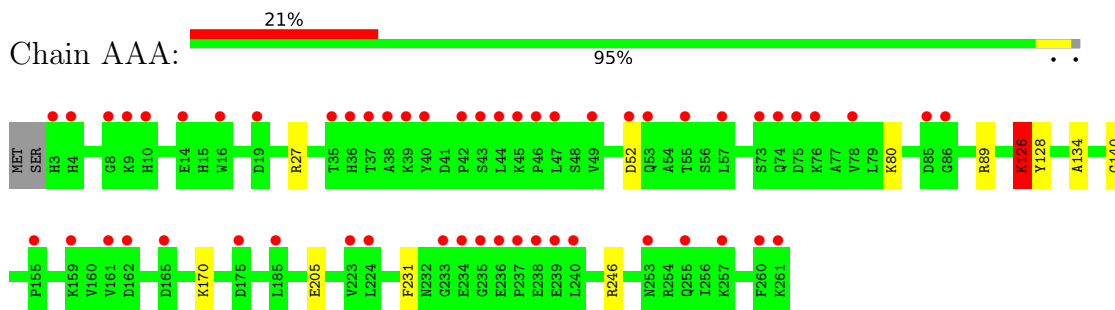
4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	42.56Å 41.61Å 72.87Å 90.00° 104.41° 90.00°	Depositor
Resolution (Å)	35.87 – 1.60 35.87 – 1.60	Depositor EDS
% Data completeness (in resolution range)	96.5 (35.87-1.60) 96.5 (35.87-1.60)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	5.62 (at 1.60Å)	Xtriage
Refinement program	REFMAC 5.8.0258	Depositor
R, R_{free}	0.225 , 0.253 0.235 , 0.266	Depositor DCC
R_{free} test set	1589 reflections (4.84%)	wwPDB-VP
Wilson B-factor (Å^2)	13.0	Xtriage
Anisotropy	0.217	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.39 , 33.7	EDS
L-test for twinning[2]	$< |L| > = 0.50, < L^2 > = 0.33$	Xtriage
Estimated twinning fraction	0.019 for h,-k,-h-l	Xtriage
F_o,F_c correlation	0.86	EDS
Total number of atoms	2308	wwPDB-VP
Average B, all atoms (Å^2)	17.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.22% of the height of the origin peak. No significant pseudotranslation is detected.*

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[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: ZN, XPI, GOL

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	AAA	0.74	1/2159 (0.0%)	0.90	2/2930 (0.1%)

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	AAA	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	AAA	126	LYS	C-N	9.21	1.55	1.34

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	AAA	246	ARG	NE-CZ-NH1	6.32	123.46	120.30
1	AAA	246	ARG	NE-CZ-NH2	-5.33	117.63	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	AAA	126	LYS	Mainchain

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	AAA	2079	0	2028	8	0
2	AAA	6	0	8	0	0
3	AAA	1	0	0	0	0
4	AAA	29	0	0	0	0
5	AAA	193	0	0	4	0
All	All	2308	0	2036	8	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 2.

All (8) 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:AAA:89:ARG:CG	5:AAA:466:HOH:O	2.42	0.67
1:AAA:89:ARG:HG2	5:AAA:466:HOH:O	1.98	0.63
1:AAA:134:ALA:O	1:AAA:140:GLY:HA3	2.12	0.49
1:AAA:126:LYS:HE3	1:AAA:128:TYR:CZ	2.48	0.48
1:AAA:89:ARG:HG3	5:AAA:466:HOH:O	2.10	0.43
1:AAA:80:LYS:HD3	5:AAA:572:HOH:O	2.19	0.43
1:AAA:170[A]:LYS:HE3	1:AAA:231:PHE:O	2.19	0.42
1:AAA:27:ARG:HG3	1:AAA:205:GLU:HB3	2.03	0.41

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	AAA	262/260 (101%)	251 (96%)	11 (4%)	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	AAA	226/225 (100%)	224 (99%)	2 (1%)	75 62

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	AAA	52	ASP
1	AAA	126	LYS

Sometimes 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 oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 3 ligands modelled in this entry, 1 is monoatomic - leaving 2 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	GOL	AAA	301	-	5,5,5	0.20	0	5,5,5	0.33	0
4	XPI	AAA	303	3	30,31,31	0.47	0	38,45,45	0.99	4 (10%)

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	GOL	AAA	301	-	-	0/4/4/4	-
4	XPI	AAA	303	3	-	4/20/32/32	0/3/3/3

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	AAA	303	XPI	C6-C5-N4	-2.77	111.10	120.40
4	AAA	303	XPI	C14-C5-N4	2.67	129.38	120.40
4	AAA	303	XPI	O12-S9-O10	-2.07	115.35	118.76
4	AAA	303	XPI	C5-N4-C3	2.03	133.01	127.86

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	AAA	303	XPI	C25-C22-O23-C24
4	AAA	303	XPI	C7-C8-S9-O10
4	AAA	303	XPI	C13-C8-S9-O10
4	AAA	303	XPI	C7-C8-S9-N11

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 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 XPI AAA 303
Bond lengths | Bond angles
Torsions | Rings
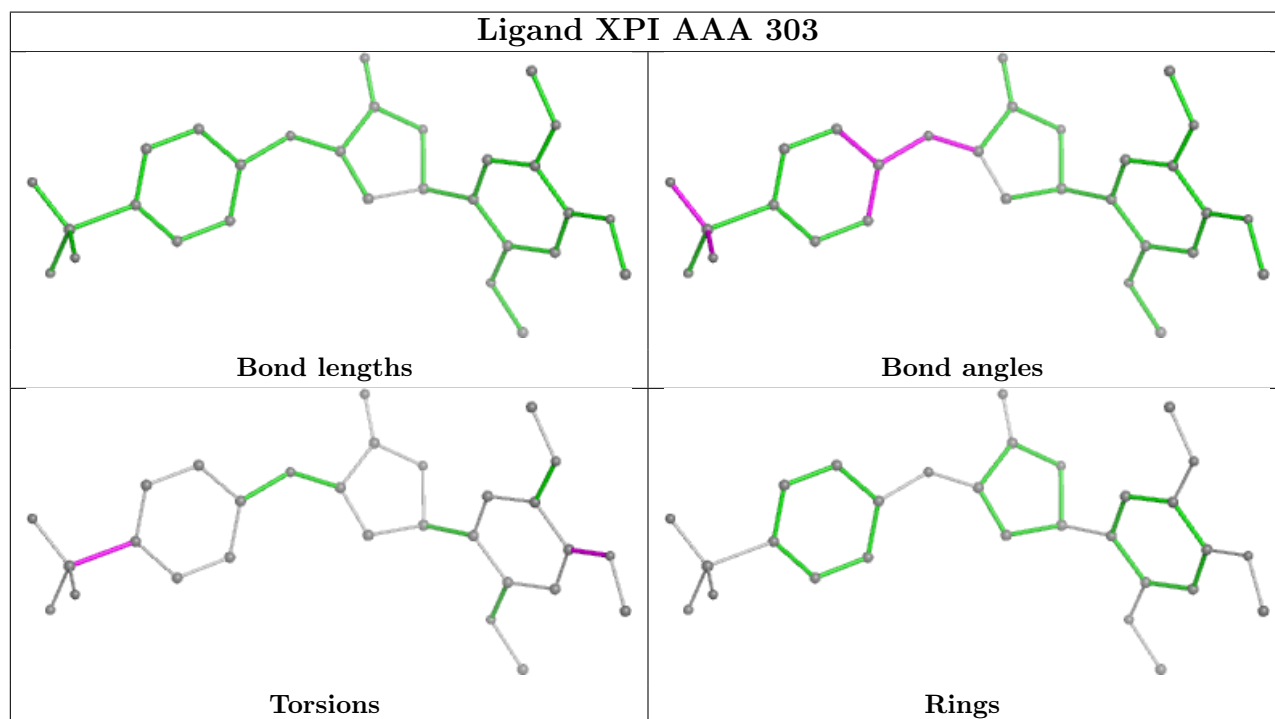
5.7 Other polymers ⓘ

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	AAA	258/260 (99%)	1.37	54 (20%)	3	2	7, 14, 29, 46	9 (3%)

All (54) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	AAA	3	HIS	7.3
1	AAA	4	HIS	6.2
1	AAA	46	PRO	5.8
1	AAA	235	GLY	5.3
1	AAA	76	LYS	4.2
1	AAA	42	PRO	4.1
1	AAA	237	PRO	4.0
1	AAA	224	LEU	3.9
1	AAA	45	LYS	3.7
1	AAA	261	LYS	3.7
1	AAA	8	GLY	3.6
1	AAA	44	LEU	3.4
1	AAA	9	LYS	3.4
1	AAA	37	THR	3.4
1	AAA	236	GLU	3.4
1	AAA	75	ASP	3.4
1	AAA	53[A]	GLN	3.3
1	AAA	253	ASN	3.3
1	AAA	255	GLN	3.2
1	AAA	223	VAL	3.1
1	AAA	165	ASP	3.0
1	AAA	175[A]	ASP	3.0
1	AAA	239[A]	GLU	3.0
1	AAA	47	LEU	2.9
1	AAA	40	TYR	2.8
1	AAA	57	LEU	2.8
1	AAA	85[A]	ASP	2.7

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Mol	Chain	Res	Type	RSRZ
1	AAA	10	HIS	2.7
1	AAA	55	THR	2.6
1	AAA	257	LYS	2.6
1	AAA	238	GLU	2.6
1	AAA	36	HIS	2.6
1	AAA	74	GLN	2.5
1	AAA	49	VAL	2.5
1	AAA	38	ALA	2.5
1	AAA	260	PHE	2.4
1	AAA	86	GLY	2.4
1	AAA	159	LYS	2.4
1	AAA	162	ASP	2.4
1	AAA	234	GLU	2.4
1	AAA	52	ASP	2.4
1	AAA	16	TRP	2.4
1	AAA	233	GLY	2.4
1	AAA	14	GLU	2.3
1	AAA	78	VAL	2.3
1	AAA	19	ASP	2.2
1	AAA	39	LYS	2.2
1	AAA	240	LEU	2.2
1	AAA	161	VAL	2.2
1	AAA	185	LEU	2.1
1	AAA	73	SER	2.1
1	AAA	155	PRO	2.1
1	AAA	43	SER	2.1
1	AAA	35	THR	2.0

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.
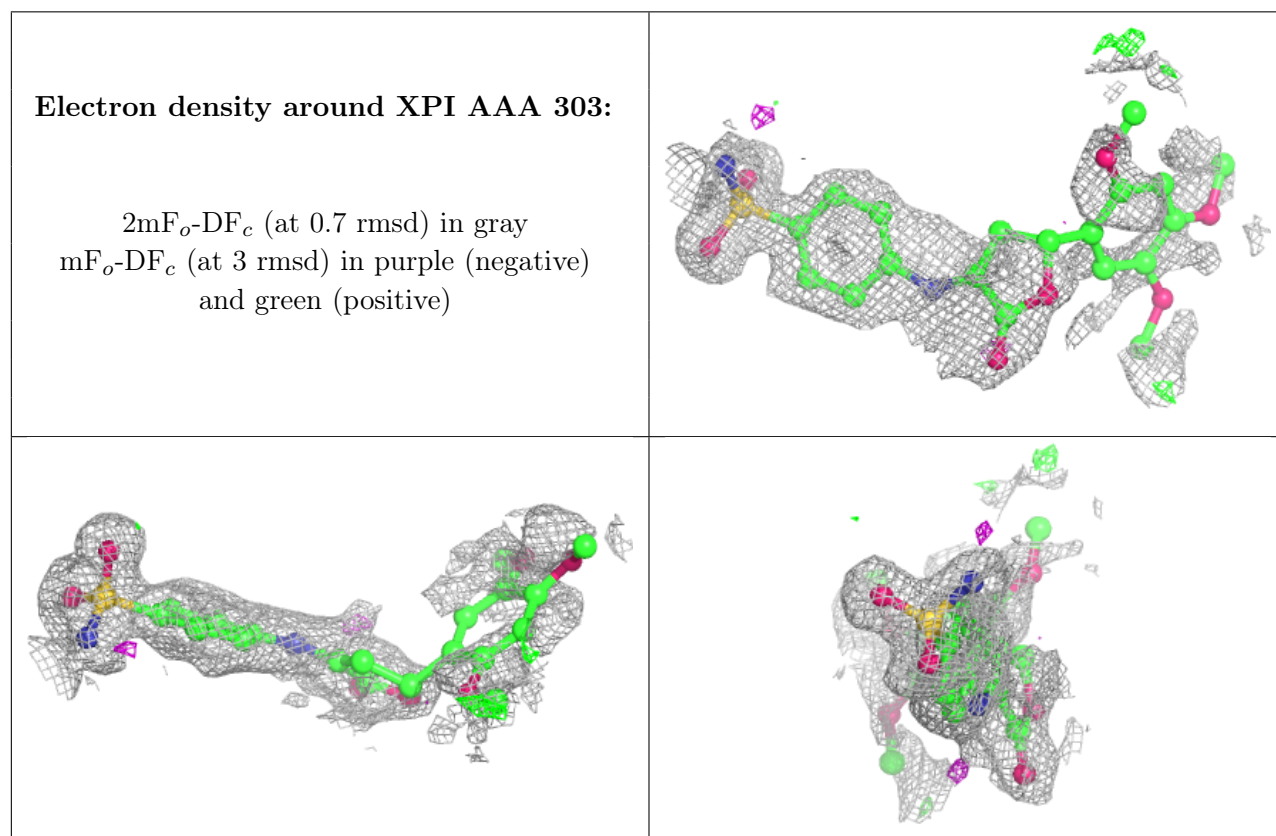
6.4 Ligands ⓘ

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, 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(Å^2)	Q<0.9
2	GOL	AAA	301	6/6	0.62	0.31	27,34,37,38	0
4	XPI	AAA	303	29/29	0.89	0.26	8,42,79,82	0
3	ZN	AAA	302	1/1	1.00	0.02	7,7,7,7	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 XPI AAA 303:

$2mF_o$-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.