W O R L D W I D E
wwPDB
P R O T E I N   D A T A   B A N K

wwPDB X-ray Structure Validation Summary Report ⓘ

Jul 2, 2025 – 05:15 pm BST

PDB ID	:	9RI1 / pdb_00009ri1
Title	:	SARS-CoV-2 with a bound inhibitor
Authors	:	Mac Sweeney, A.
Deposited on	:	2025-06-10
Resolution	:	1.31 Å(reported)

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

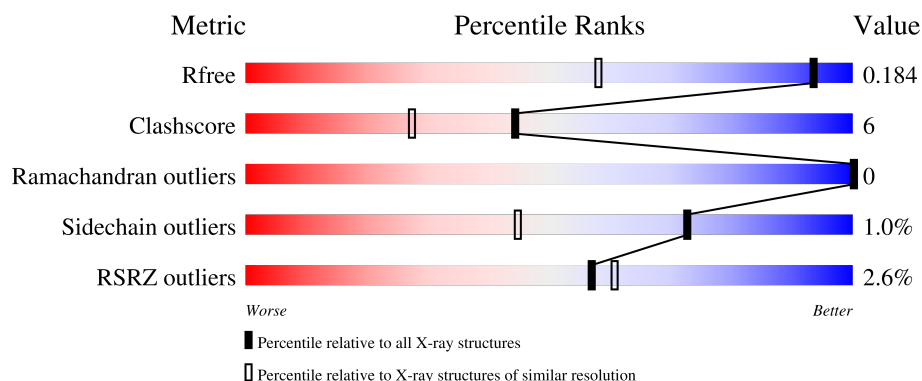|		
MolProbity	:	4-5-2 with Phenix2.0rc1
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0rc1
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.003 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.44

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 1.31 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		0.184
Clashscore		6
Ramachandran outliers		0
Sidechain outliers		1.0%
RSRZ outliers		2.6%

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	1387 (1.30-1.30)
Clashscore	180529	1497 (1.30-1.30)
Ramachandran outliers	177936	1455 (1.30-1.30)
Sidechain outliers	177891	1455 (1.30-1.30)
RSRZ outliers	164620	1384 (1.30-1.30)

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	306	88% 11% •
1	B	306	5% 88% 10% •

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

WORLDWIDE wwPDB PROTEIN DATA BANK

| Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	PG4	A	402	-	-	X	-

2 Entry composition ⓘ

There are 7 unique types of molecules in this entry. The entry contains 10186 atoms, of which 4757 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 3C-like proteinase nsp5.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	306	Total	C	H	N	O	S	78	6	0
			4764	1522	2364	405	448	25			
1	B	301	Total	C	H	N	O	S	78	6	0
			4688	1496	2324	401	442	25			

- Molecule 2 is (4 {R})- {N}-(3,4-dipropoxyphenyl)-2-oxidanylidene-3,4-dihydro-1 {H}-q uinoline-4-carboxamide (CCD ID: A1JGD) (formula: $C_{22}H_{26}N_2O_4$) (labeled as "Ligand of Interest" by depositor).
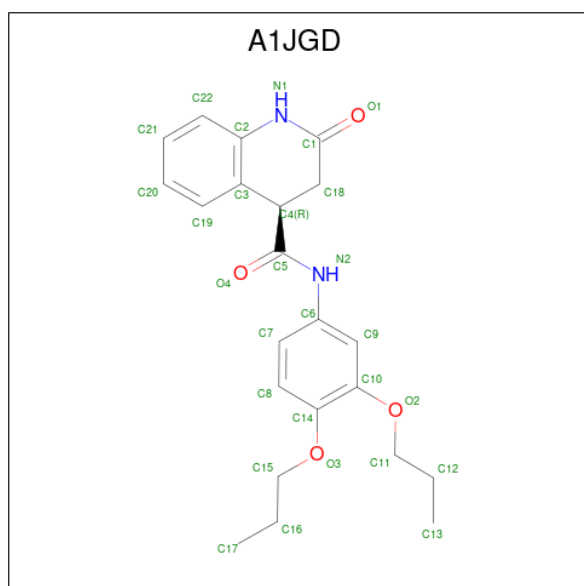
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	H	N	O	0	0
			54	22	26	2	4		
2	B	1	Total	C	H	N	O	0	0
			54	22	26	2	4		

- Molecule 3 is TETRAETHYLENE GLYCOL (CCD ID: PG4) (formula: $C_8H_{18}O_5$).

PG4

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total 30	C 8	H 17	O 5	1	0

- Molecule 4 is BROMIDE ION (CCD ID: BR) (formula: Br).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total 1	Br 1	0	0
4	B	2	Total 2	Br 2	0	0

- Molecule 5 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	1	Total 1	Na 1	0	0

- Molecule 6 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	1	Total 1	Cl 1	0	0

- Molecule 7 is water.

| Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	355	Total 355	O 355	0	0
7	B	236	Total 236	O 236	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: 3C-like proteinase nsp5

Chain A:

• Molecule 1: 3C-like proteinase nsp5

Chain B:
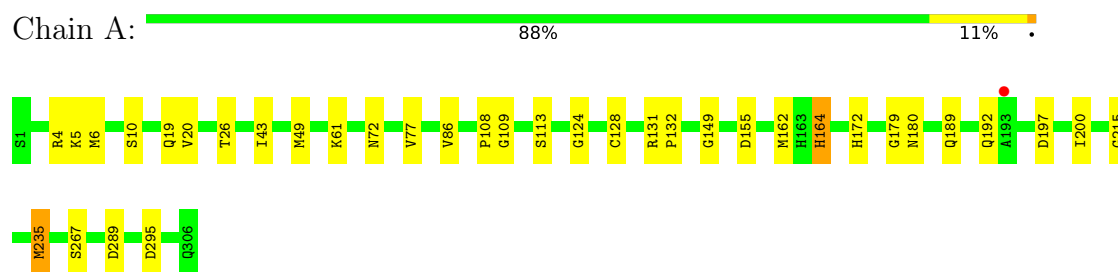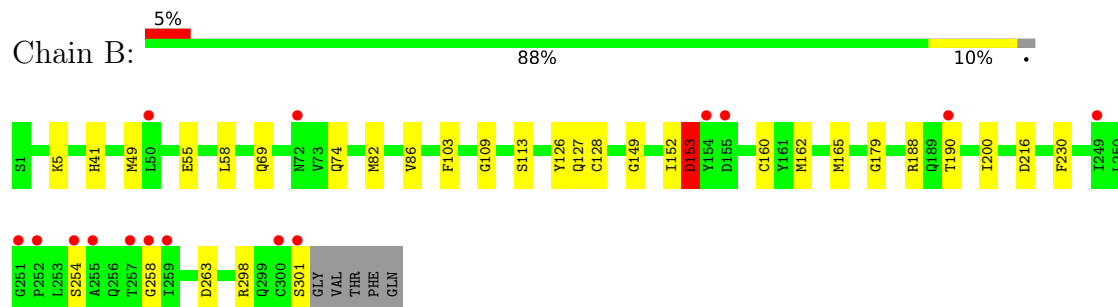
4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	67.76Å 100.96Å 104.31Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	72.55 – 1.31 72.55 – 1.31	Depositor EDS
% Data completeness (in resolution range)	78.0 (72.55-1.31) 78.0 (72.55-1.31)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.98 (at 1.31Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.146 , 0.180 0.154 , 0.184	Depositor DCC
R_{free} test set	8581 reflections (4.95%)	wwPDB-VP
Wilson B-factor (Å^2)	11.0	Xtriage
Anisotropy	1.115	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.43 , 45.3	EDS
L-test for twinning[2]	$< |L| > = 0.48, < L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.015 for -h,l,k	Xtriage
F_o,F_c correlation	0.98	EDS
Total number of atoms	10186	wwPDB-VP
Average B, all atoms (Å^2)	19.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.54% 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: PG4, A1JGD, BR, CL, NA

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	1.29	8/2465 (0.3%)	1.29	7/3348 (0.2%)
1	B	1.14	0/2425	1.26	5/3295 (0.2%)
All	All	1.22	8/4890 (0.2%)	1.27	12/6643 (0.2%)

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	77	VAL	C-O	6.17	1.31	1.24
1	A	215	GLY	C-O	5.78	1.30	1.24
1	A	172	HIS	CE1-NE2	5.68	1.38	1.32
1	A	20	VAL	C-O	-5.36	1.18	1.24
1	A	180	ASN	C-O	5.34	1.30	1.24

The worst 5 of 12 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	263	ASP	CA-CB-CG	6.90	119.50	112.60
1	A	164	HIS	CB-CG-CD2	-6.20	123.14	131.20
1	B	160	CYS	CA-C-O	-6.11	111.67	118.69
1	A	10	SER	CA-C-O	-5.54	112.58	119.18
1	B	230	PHE	CA-CB-CG	-5.40	108.40	113.80

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	2400	2364	2359	23	0
1	B	2364	2324	2317	34	1
2	A	28	26	0	0	0
2	B	28	26	0	5	0
3	A	13	17	18	18	0
4	A	1	0	0	0	0
4	B	2	0	0	0	0
5	B	1	0	0	0	0
6	B	1	0	0	0	0
7	A	355	0	0	3	2
7	B	236	0	0	2	1
All	All	5429	4757	4694	56	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 6.

The worst 5 of 56 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:B:301:SER:C	7:B:573:HOH:O	1.85	1.15
1:A:5:LYS:HB3	3:A:402:PG4:H31	1.43	1.00
1:A:86[B]:VAL:HG22	1:A:162[B]:MET:HE1	1.54	0.90
3:A:402:PG4:H81	1:B:5:LYS:HG2	1.53	0.90
1:A:197:ASP:OD2	7:A:501:HOH:O	1.98	0.82

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:B:55:GLU:OE1	7:A:547:HOH:O[2_555]	1.84	0.36
7:A:626:HOH:O	7:B:674:HOH:O[2_554]	1.96	0.24

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	310/306 (101%)	303 (98%)	7 (2%)	0	100	100
1	B	305/306 (100%)	301 (99%)	4 (1%)	0	100	100
All	All	615/612 (100%)	604 (98%)	11 (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	269/263 (102%)	266 (99%)	3 (1%)	70	41
1	B	265/263 (101%)	263 (99%)	2 (1%)	79	55
All	All	534/526 (102%)	529 (99%)	5 (1%)	73	50

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	128	CYS
1	A	155	ASP
1	A	192	GLN
1	B	153	ASP
1	B	216	ASP

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	B	180	ASN
1	B	228	ASN
1	A	273	GLN
1	B	69	GLN
1	B	72	ASN

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 8 ligands modelled in this entry, 5 are monoatomic - leaving 3 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	#$|Z| > 2$
3	PG4	A	402	-	12,12,12	0.62	0	11,11,11	1.11	1 (9%)
2	A1JGD	B	401	-	30,30,30	1.22	3 (10%)	36,40,40	0.88	1 (2%)
2	A1JGD	A	401	-	30,30,30	1.09	4 (13%)	36,40,40	0.96	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
3	PG4	A	402	-	-	1/10/10/10	-
2	A1JGD	B	401	-	-	3/16/28/28	0/3/3/3
2	A1JGD	A	401	-	-	0/16/28/28	0/3/3/3

The worst 5 of 7 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	401	A1JGD	O1-C1	-2.95	1.17	1.23
2	B	401	A1JGD	C2-N1	2.93	1.44	1.39
2	A	401	A1JGD	O3-C15	2.46	1.52	1.43
2	A	401	A1JGD	C12-C11	2.38	1.65	1.49
2	B	401	A1JGD	C1-N1	2.32	1.37	1.35

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	401	A1JGD	O3-C15-C16	-2.55	97.78	109.91
3	A	402	PG4	O4-C6-C5	2.37	121.09	110.39
2	A	401	A1JGD	C8-C7-C6	-2.23	117.72	120.30

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	402	PG4	C3-C4-O3-C5
2	B	401	A1JGD	C8-C14-O3-C15
2	B	401	A1JGD	C16-C15-O3-C14
2	B	401	A1JGD	C10-C14-O3-C15

There are no ring outliers.

2 monomers are involved in 23 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	402	PG4	18	0
2	B	401	A1JGD	5	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.

Ligand A1JGD B 401

Bond lengths · Bond angles · Torsions · Rings

Ligand A1JGD A 401

Bond lengths · Bond angles · Torsions · Rings
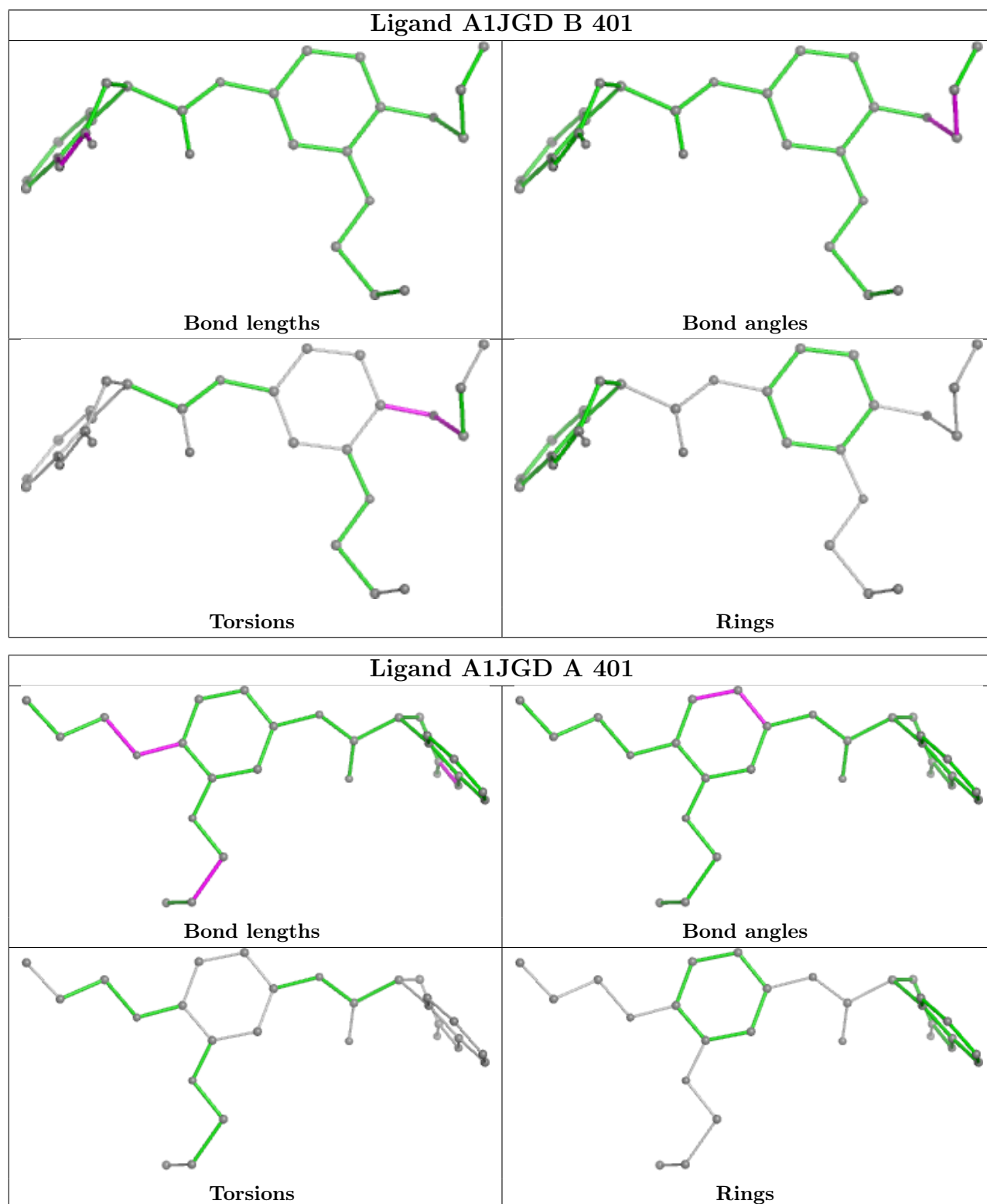
5.7 Other polymers ⓘ

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(Å²)	Q<0.9
1	A	306/306 (100%)	-0.59	1 (0%)	90	91	6, 14, 27, 49	6 (1%)
1	B	301/306 (98%)	-0.13	15 (4%)	35	38	6, 18, 44, 65	6 (1%)
All	All	607/612 (99%)	-0.36	16 (2%)	57	61	6, 15, 40, 65	12 (1%)

The worst 5 of 16 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	154	TYR	6.6
1	B	50	LEU	5.6
1	B	255	ALA	4.7
1	B	249	ILE	4.2
1	B	257	THR	3.3

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 oligosaccharides 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
3	PG4	A	402	13/13	0.93	0.12	0,26,34,40	1
2	A1JGD	B	401	28/28	0.97	0.07	16,27,41,46	0
2	A1JGD	A	401	28/28	0.99	0.04	11,15,25,26	0
4	BR	A	403	1/1	1.00	0.04	22,22,22,22	0
4	BR	B	404	1/1	1.00	0.03	20,20,20,20	0
4	BR	B	405	1/1	1.00	0.01	14,14,14,14	0
5	NA	B	402	1/1	1.00	0.03	18,18,18,18	0
6	CL	B	403	1/1	1.00	0.02	25,25,25,25	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.
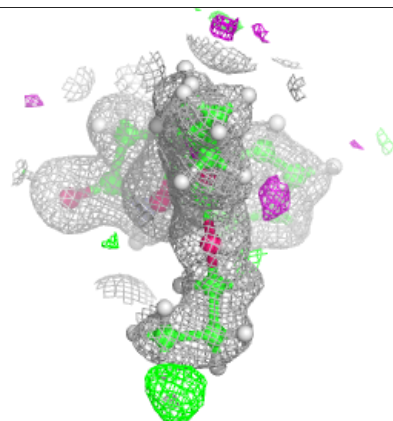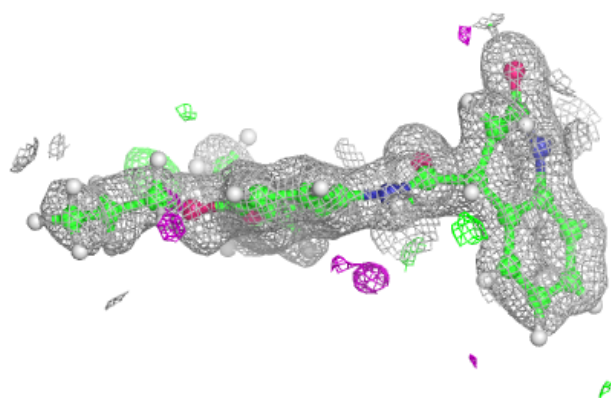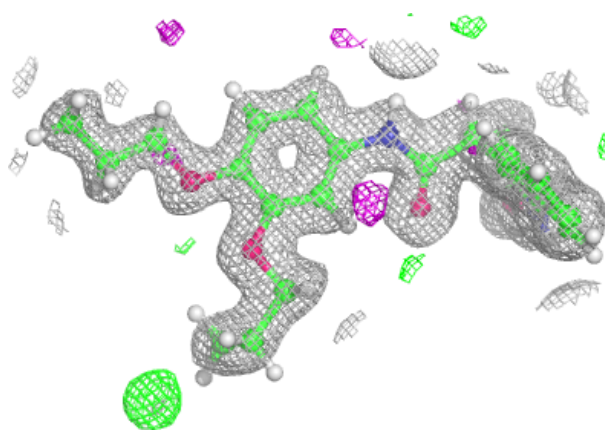
Electron density around A1JGD B 401:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative) and green (positive)
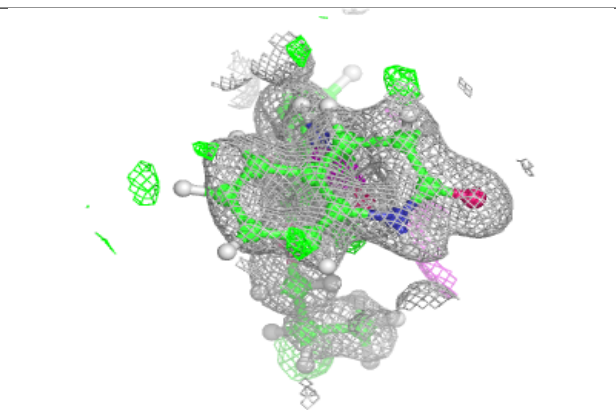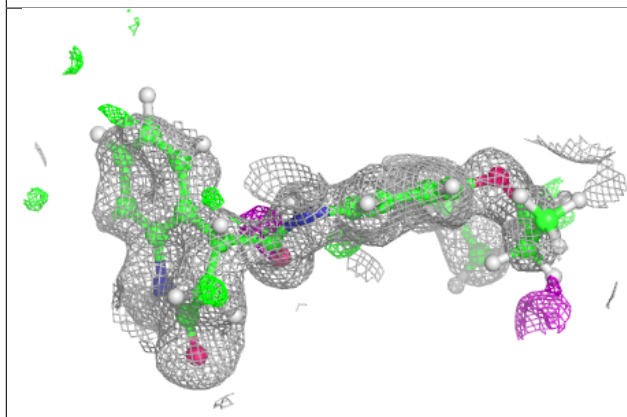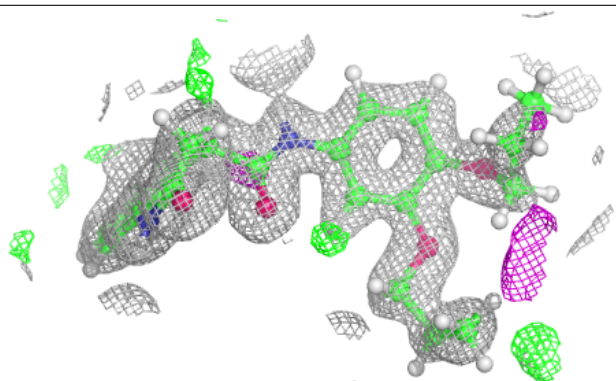
Electron density around A1JGD A 401:

$2mF_o-DF_c$ (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.