



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 05:33 PM UTC

PDB ID : 7KN7 / pdb_00007kn7
Title : Crystal structure of SARS-CoV-2 receptor binding domain complexed with nanobody VHH W and antibody Fab CC12.3
Authors : Liu, H.; Yuan, M.; Zhu, X.; Wu, N.C.; Wilson, I.A.
Deposited on : 2020-11-04
Resolution : 2.73 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

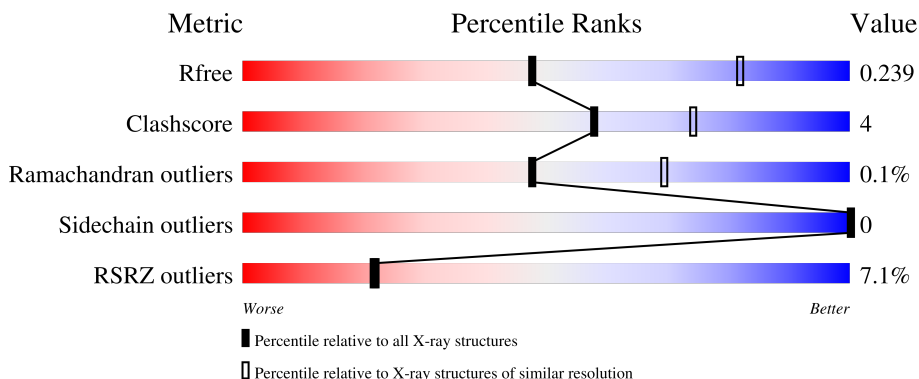
1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.73 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	1819 (2.76-2.72)
Clashscore	190562	1866 (2.76-2.72)
Ramachandran outliers	187476	1830 (2.76-2.72)
Sidechain outliers	187428	1831 (2.76-2.72)
RSRZ outliers	180081	1819 (2.76-2.72)

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	231	7% 70% 12% 18%
2	B	140	14% 76% 14% 11%
3	H	220	5% 89% 10%
4	L	214	2% 93% 7%

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 5699 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 Spike protein S1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	189	Total	C	N	O	S	0	0	0
			1484	955	245	276	8			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	542	SER	-	expression tag	UNP P0DTC2
A	543	GLY	-	expression tag	UNP P0DTC2
A	544	HIS	-	expression tag	UNP P0DTC2
A	545	HIS	-	expression tag	UNP P0DTC2
A	546	HIS	-	expression tag	UNP P0DTC2
A	547	HIS	-	expression tag	UNP P0DTC2
A	548	HIS	-	expression tag	UNP P0DTC2
A	549	HIS	-	expression tag	UNP P0DTC2

- Molecule 2 is a protein called VHH W.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	125	Total	C	N	O	S	0	0	0
			954	593	164	192	5			

- Molecule 3 is a protein called CC12.3 Fab heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	H	217	Total	C	N	O	S	0	0	0
			1612	1023	266	317	6			

- Molecule 4 is a protein called CC12.3 Fab light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	L	213	Total	C	N	O	S	0	0	0
			1635	1021	279	331	4			

- Molecule 5 is 2-acetamido-2-deoxy-beta-D-glucopyranose (CCD ID: NAG) (formula: $C_8H_{15}NO_6$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	C	N	O	0	0
			14	8	1	5		

4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	192.40Å 105.88Å 55.75Å 90.00° 101.86° 90.00°	Depositor
Resolution (Å)	49.18 – 2.73 49.18 – 2.73	Depositor EDS
% Data completeness (in resolution range)	96.6 (49.18-2.73) 96.6 (49.18-2.73)	Depositor EDS
R_{merge}	0.18	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.26 (at 2.73Å)	Xtriage
Refinement program	PHENIX 1.16_3549	Depositor
R, R_{free}	0.203 , 0.241 0.202 , 0.239	Depositor DCC
R_{free} test set	1478 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å ²)	46.2	Xtriage
Anisotropy	0.330	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 34.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	5699	wwPDB-VP
Average B, all atoms (Å ²)	49.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.96% 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: NAG

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	0.18	0/1526	0.43	0/2076
2	B	0.17	0/977	0.45	0/1324
3	H	0.16	0/1651	0.46	0/2249
4	L	0.18	0/1670	0.47	0/2266
All	All	0.17	0/5824	0.45	0/7915

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	1484	0	1385	15	0
2	B	954	0	870	13	0
3	H	1612	0	1548	15	0
4	L	1635	0	1592	8	0
5	A	14	0	13	0	0
All	All	5699	0	5408	49	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 (49) 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)
2:B:34:ILE:HG21	2:B:78:VAL:HG11	1.54	0.87
3:H:66:ARG:NH2	3:H:86:ASP:OD2	2.18	0.75
2:B:82:MET:HE2	2:B:82(C):LEU:HD21	1.75	0.68
2:B:2:VAL:HA	2:B:25:SER:O	2.00	0.61
3:H:12:ILE:HD11	3:H:18:LEU:HD22	1.83	0.61
2:B:22:CYS:HB3	2:B:78:VAL:CG1	2.37	0.55
3:H:62:SER:O	3:H:66:ARG:NH1	2.40	0.54
3:H:33:TYR:HB2	3:H:95:ASP:O	2.08	0.53
2:B:100(F):TRP:CZ2	2:B:103:ARG:HD3	2.45	0.51
2:B:22:CYS:HB3	2:B:78:VAL:HG13	1.94	0.50
2:B:12:VAL:HG11	2:B:82(C):LEU:HD13	1.96	0.48
1:A:418:ILE:HA	1:A:422:ASN:HD22	1.79	0.47
1:A:335:LEU:HD23	1:A:362:VAL:O	2.14	0.47
1:A:392:PHE:CD1	1:A:515:PHE:HB3	2.49	0.47
1:A:439:ASN:O	1:A:443:SER:HB2	2.14	0.47
3:H:34:MET:HE2	3:H:78:LEU:HD22	1.97	0.47
4:L:33:LEU:HD13	4:L:34:ALA:N	2.29	0.47
2:B:50:CYS:SG	2:B:100(B):CYS:CB	3.03	0.47
3:H:47:TRP:HZ2	3:H:50:VAL:HG12	1.80	0.46
1:A:489:TYR:OH	3:H:94:ARG:NH2	2.49	0.46
3:H:209:LYS:HE2	4:L:123:GLU:OE1	2.15	0.46
4:L:37:GLN:HB2	4:L:47:LEU:HD11	1.96	0.46
2:B:11:LEU:HD23	2:B:110:THR:HB	1.98	0.46
3:H:18:LEU:HD23	3:H:82:MET:HE3	1.97	0.46
2:B:24:ALA:O	2:B:76:ASN:ND2	2.50	0.45
4:L:155:GLN:OE1	4:L:158:ASN:ND2	2.50	0.44
3:H:195:ILE:HG12	3:H:210:LYS:HA	2.00	0.44
4:L:37:GLN:HG3	4:L:86:TYR:CE2	2.52	0.44
2:B:85:GLU:H	2:B:85:GLU:CD	2.26	0.43
1:A:354:ASN:O	1:A:398:ASP:HA	2.19	0.43
3:H:18:LEU:HD23	3:H:82:MET:CE	2.48	0.43
3:H:12:ILE:CD1	3:H:18:LEU:HD22	2.48	0.43
1:A:399:SER:HA	1:A:510:VAL:O	2.18	0.43
2:B:100(F):TRP:CH2	2:B:103:ARG:HB3	2.53	0.43
1:A:431:GLY:HA3	1:A:513:LEU:O	2.19	0.43
1:A:363:ALA:O	1:A:527:PRO:HD3	2.19	0.43
1:A:355:ARG:HD2	1:A:396:TYR:CD1	2.54	0.42
3:H:171:GLN:NE2	3:H:177:SER:HB2	2.33	0.42
1:A:360:ASN:HA	1:A:523:THR:O	2.18	0.42
2:B:67:PHE:HA	2:B:81:GLN:O	2.19	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:378:LYS:HE3	1:A:378:LYS:HB3	1.92	0.41
4:L:113:PRO:HB3	4:L:139:PHE:CD2	2.55	0.41
3:H:162:GLY:O	3:H:182:VAL:HA	2.20	0.41
4:L:186:TYR:CZ	4:L:211:ARG:HG3	2.56	0.41
1:A:438:SER:HB3	1:A:509:ARG:HG3	2.02	0.41
3:H:20:LEU:HG	3:H:82:MET:HE2	2.03	0.41
4:L:159:SER:HA	4:L:178:THR:O	2.21	0.40
1:A:357:ARG:HE	1:A:357:ARG:HB2	1.75	0.40
1:A:403:ARG:HG2	1:A:495:TYR:CE1	2.56	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	185/231 (80%)	177 (96%)	8 (4%)	0	100	100
2	B	123/140 (88%)	119 (97%)	4 (3%)	0	100	100
3	H	213/220 (97%)	207 (97%)	6 (3%)	0	100	100
4	L	211/214 (99%)	203 (96%)	7 (3%)	1 (0%)	24	40
All	All	732/805 (91%)	706 (96%)	25 (3%)	1 (0%)	48	69

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
4	L	68	GLY

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	157/203 (77%)	157 (100%)	0	100	100
2	B	99/113 (88%)	99 (100%)	0	100	100
3	H	177/186 (95%)	177 (100%)	0	100	100
4	L	184/185 (100%)	184 (100%)	0	100	100
All	All	617/687 (90%)	617 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	76	ASN
2	B	100(G)	HIS
2	B	108	GLN
3	H	81	GLN
3	H	164	HIS
3	H	171	GLN
4	L	42	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](#)

1 ligand is 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	$\# Z > 2$
5	NAG	A	601	1	14,14,15	0.55	0	17,19,21	0.63	0

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
5	NAG	A	601	1	-	2/6/23/26	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

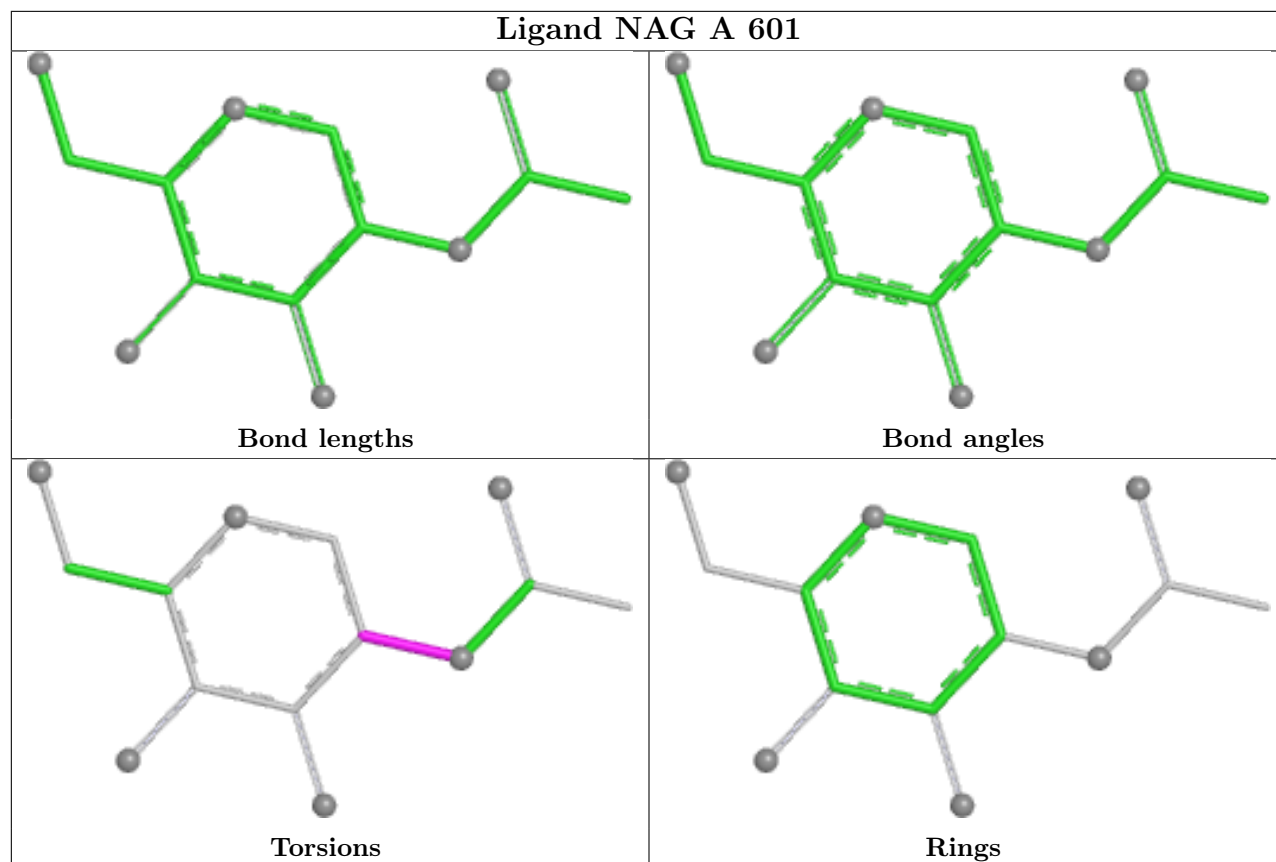
All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	601	NAG	C3-C2-N2-C7
5	A	601	NAG	C1-C2-N2-C7

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	189/231 (81%)	0.38	17 (8%) 15 15	23, 44, 97, 120	0
2	B	125/140 (89%)	1.08	19 (15%) 5 5	38, 68, 93, 118	0
3	H	217/220 (98%)	0.17	12 (5%) 30 30	21, 39, 76, 111	0
4	L	213/214 (99%)	0.07	5 (2%) 61 58	25, 42, 67, 82	0
All	All	744/805 (92%)	0.35	53 (7%) 22 21	21, 45, 84, 120	0

All (53) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	H	131	THR	5.2
3	H	128	SER	4.9
2	B	41	PRO	4.9
1	A	394	ASN	3.9
3	H	214	LYS	3.6
1	A	523	THR	3.5
2	B	12	VAL	3.5
1	A	521	PRO	3.5
1	A	390	LEU	3.5
3	H	191	THR	3.4
2	B	40	ALA	3.4
3	H	132	SER	3.3
4	L	76	SER	3.3
2	B	113	SER	3.2
1	A	393	THR	3.1
1	A	334	ASN	3.1
2	B	101	ASP	3.1
1	A	527	PRO	3.1
1	A	525	CYS	3.0
1	A	524	VAL	3.0
2	B	112	SER	2.9

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Mol	Chain	Res	Type	RSRZ
3	H	186	SER	2.9
3	H	129	LYS	2.8
2	B	60	VAL	2.8
2	B	29	LEU	2.8
2	B	74	ALA	2.8
1	A	385	THR	2.7
3	H	133	GLY	2.7
1	A	480	CYS	2.7
1	A	392	PHE	2.7
1	A	391	CYS	2.6
2	B	63	VAL	2.6
3	H	127	SER	2.6
2	B	65	GLY	2.5
1	A	346	ARG	2.4
2	B	44	GLU	2.4
2	B	42	GLY	2.4
1	A	522	ALA	2.4
4	L	56	THR	2.4
2	B	18	LEU	2.4
2	B	43	LYS	2.3
1	A	496	GLY	2.3
3	H	134	GLY	2.3
2	B	2	VAL	2.3
2	B	61	ASP	2.2
1	A	357	ARG	2.1
4	L	142	ARG	2.1
3	H	74	SER	2.1
2	B	62	SER	2.1
3	H	193	THR	2.1
2	B	85	GLU	2.0
4	L	194	CYS	2.0
4	L	213	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](#)

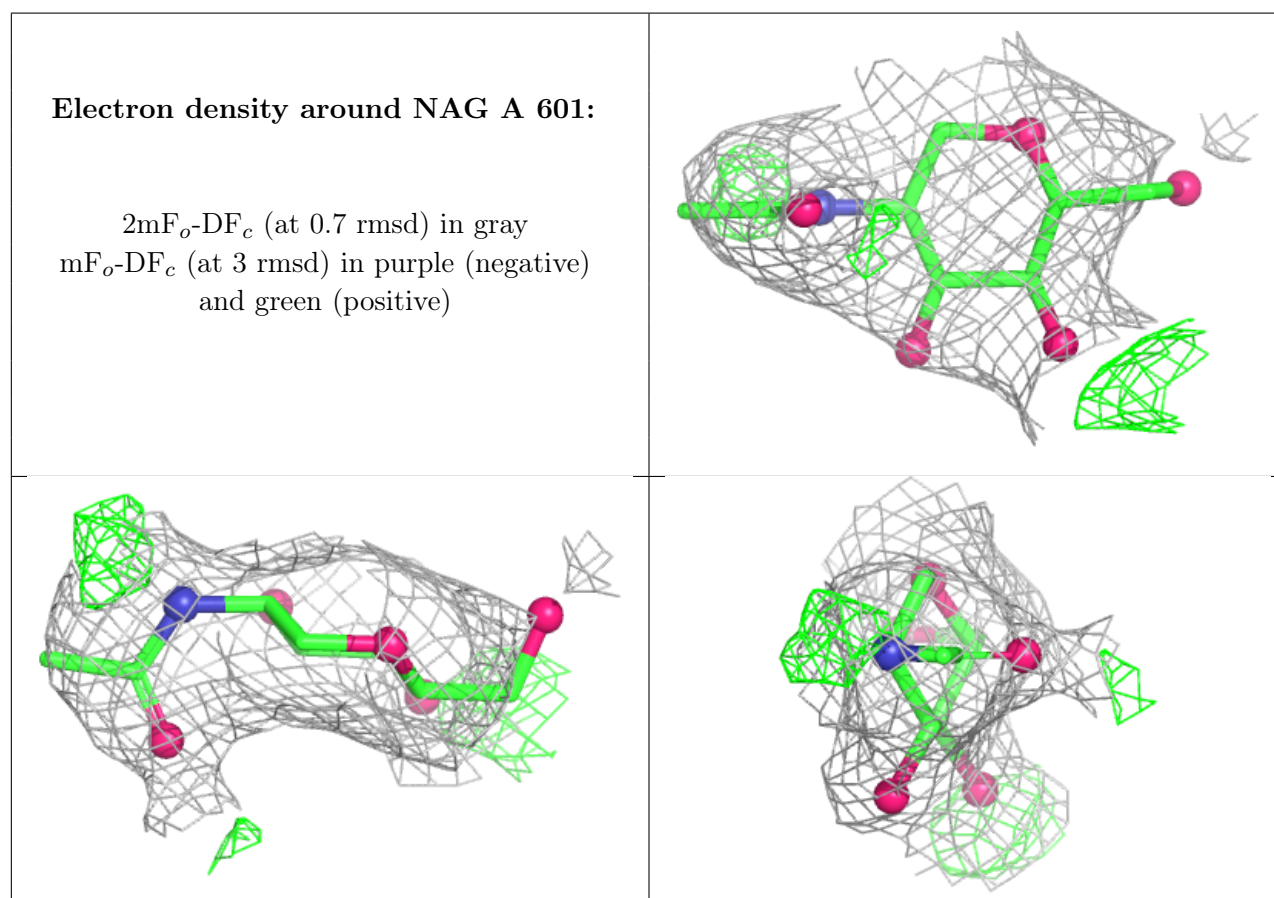
There are no oligosaccharides in this entry.

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
5	NAG	A	601	14/15	0.81	0.17	73,79,84,87	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.