



# Full wwPDB X-ray Structure Validation Report ⓘ

Dec 14, 2021 – 12:09 pm GMT

PDB ID : 6ZCZ  
Title : Crystal structure of receptor binding domain of SARS-CoV-2 Spike glycoprotein in ternary complex with EY6A Fab and a nanobody.  
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Deposited on : 2020-06-12  
Resolution : 2.65 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](mailto: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.

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

MolProbity : 4.02b-467  
Mogul : 1.8.4, CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.24  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0267  
CCP4 : 7.1.010 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.24

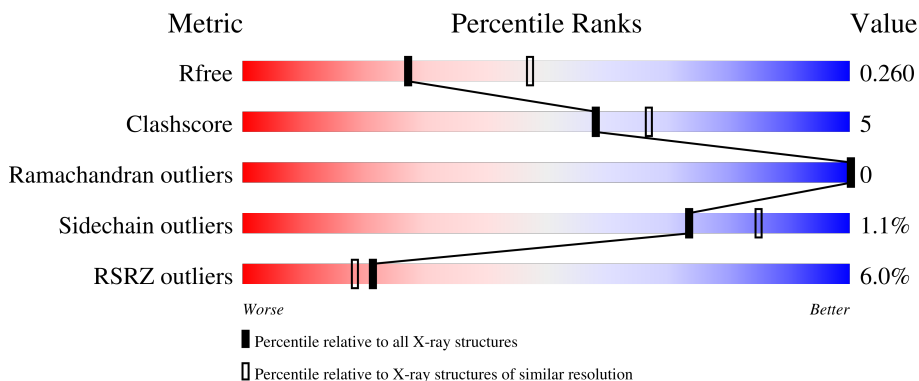
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.65 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	1332 (2.68-2.64)
Clashscore	141614	1374 (2.68-2.64)
Ramachandran outliers	138981	1349 (2.68-2.64)
Sidechain outliers	138945	1349 (2.68-2.64)
RSRZ outliers	127900	1318 (2.68-2.64)

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  $\geq 3$ , 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	E	205	 7% 87% 8% 5%
2	F	151	 6% 75% 8% 17%
3	H	226	 5% 81% 15% 5%
4	L	215	 5% 87% 13%

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:

<b>Mol</b>	<b>Type</b>	<b>Chain</b>	<b>Res</b>	<b>Chirality</b>	<b>Geometry</b>	<b>Clashes</b>	<b>Electron density</b>
6	CL	E	602	-	-	X	-

## 2 Entry composition

There are 7 unique types of molecules in this entry. The entry contains 5839 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
			Total	C	N	O	S			
1	E	195	1541	987	257	289	8	0	0	0

There are 11 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
E	324	GLU	-	expression tag	UNP P0DTC2
E	325	THR	-	expression tag	UNP P0DTC2
E	326	GLY	-	expression tag	UNP P0DTC2
E	327	HIS	-	expression tag	UNP P0DTC2
E	328	HIS	-	expression tag	UNP P0DTC2
E	329	HIS	-	expression tag	UNP P0DTC2
E	330	HIS	-	expression tag	UNP P0DTC2
E	331	HIS	-	expression tag	UNP P0DTC2
E	332	HIS	-	expression tag	UNP P0DTC2
E	527	LYS	-	expression tag	UNP P0DTC2
E	528	LYS	-	expression tag	UNP P0DTC2

- Molecule 2 is a protein called Nanobody.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	F	125	977	621	166	185	5	0	0	0

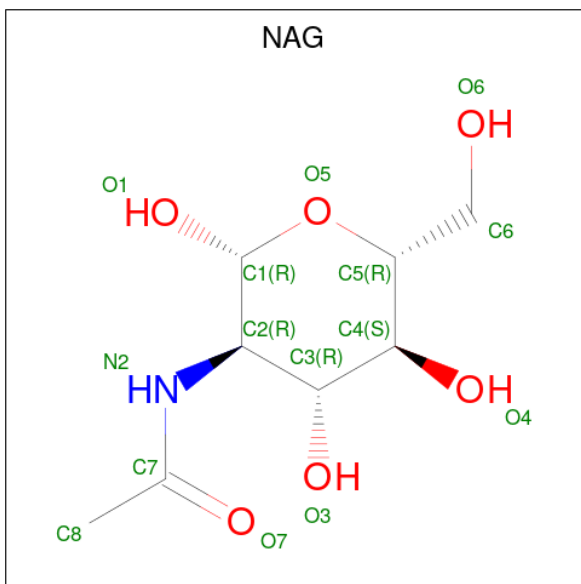
- Molecule 3 is a protein called EY6A heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	H	219	1664	1056	278	323	7	0	0	0

- Molecule 4 is a protein called EY6A light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	L	215	Total 1637	1022	273	336	6	0	0	0

- Molecule 5 is 2-acetamido-2-deoxy-beta-D-glucopyranose (three-letter code: NAG) (formula:  $C_8H_{15}NO_6$ ).



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

- Molecule 6 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	E	1	Total Cl 1 1	0	0
6	F	1	Total Cl 1 1	0	0
6	H	2	Total Cl 2 2	0	0
6	L	1	Total Cl 1 1	0	0

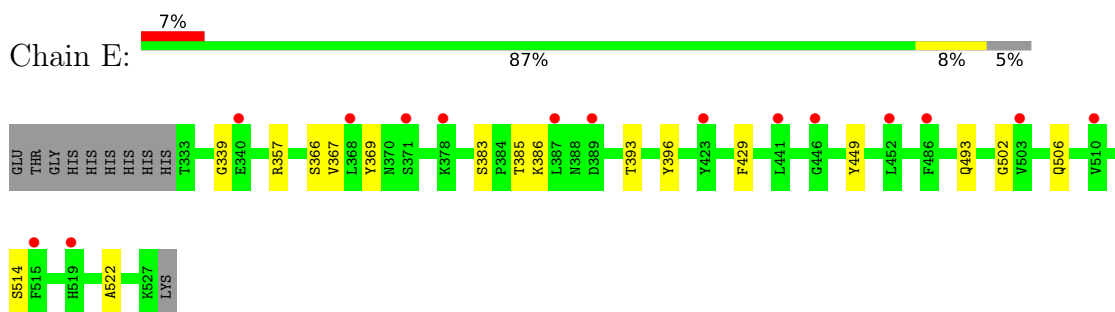
- Molecule 7 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	L	1	Total Mg 1 1	0	0

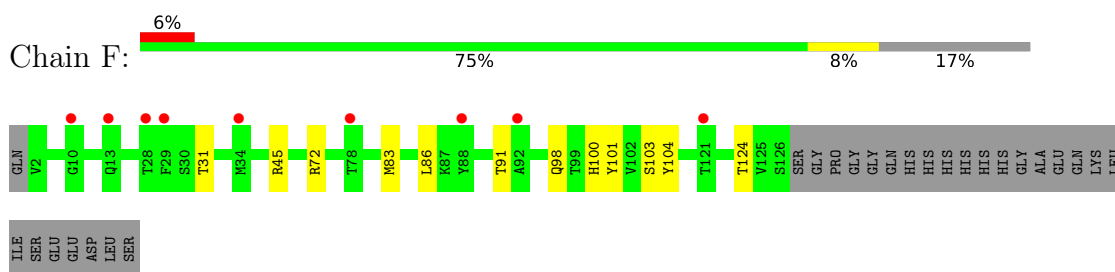
### 3 Residue-property plots [i](#)

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.

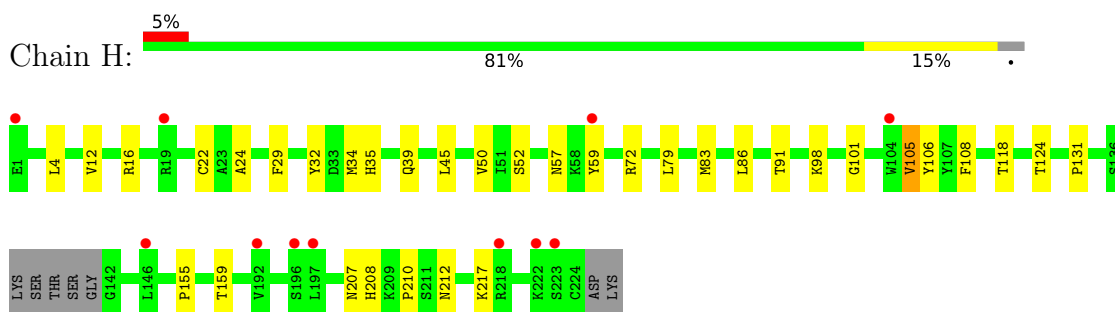
- Molecule 1: Spike protein S1



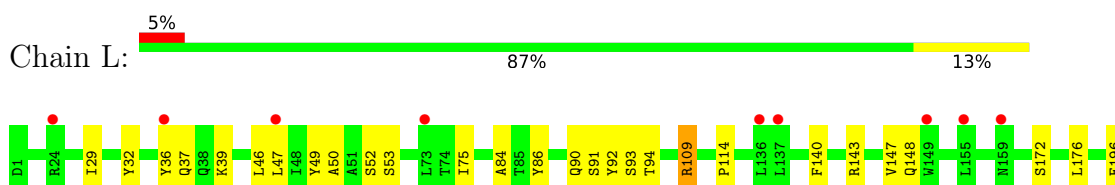
- Molecule 2: Nanobody



- Molecule 3: EY6A heavy chain



- Molecule 4: EY6A light chain





## 4 Data and refinement statistics

Property	Value	Source
Space group	H 3	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	177.87Å 177.87Å 87.72Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	35.26 – 2.65 88.93 – 2.65	Depositor EDS
% Data completeness (in resolution range)	89.5 (35.26-2.65) 89.6 (88.93-2.65)	Depositor EDS
$R_{merge}$	0.21	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	0.99 (at 2.65Å)	Xtrriage
Refinement program	PHENIX 1.18.1_3865, PHENIX 1.18.1_3865	Depositor
R, $R_{free}$	0.215 , 0.260 0.215 , 0.260	Depositor DCC
$R_{free}$ test set	1269 reflections (4.73%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	70.6	Xtrriage
Anisotropy	0.409	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	(Not available) , (Not available)	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.30$	Xtrriage
Estimated twinning fraction	0.016 for h,-h-k,-l	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	5839	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	81.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.39% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: MG, NAG, CL

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	E	0.25	0/1584	0.41	0/2156
2	F	0.24	0/1002	0.42	0/1358
3	H	0.25	0/1706	0.45	0/2323
4	L	0.25	0/1670	0.44	0/2266
All	All	0.25	0/5962	0.43	0/8103

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 [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	E	1541	0	1454	18	0
2	F	977	0	930	7	0
3	H	1664	0	1618	22	0
4	L	1637	0	1595	14	0
5	E	14	0	13	3	0
6	E	1	0	0	2	0
6	F	1	0	0	0	0
6	H	2	0	0	0	0
6	L	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
7	L	1	0	0	0	0
All	All	5839	0	5610	55	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 5.

All (55) 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:E:367:VAL:HG11	5:E:601:NAG:H83	1.71	0.73
4:L:32:TYR:HB3	4:L:91:SER:HB2	1.74	0.70
1:E:383:SER:HB2	1:E:386:LYS:HG2	1.84	0.59
3:H:22:CYS:HB3	3:H:79:LEU:HB3	1.85	0.58
4:L:39:LYS:HD3	4:L:84:ALA:HB2	1.85	0.57
1:E:383:SER:HA	4:L:94:THR:HG21	1.87	0.56
1:E:493:GLN:HE21	2:F:104:TYR:HD2	1.53	0.56
1:E:493:GLN:HG2	2:F:104:TYR:HB3	1.88	0.56
3:H:131:PRO:HD3	3:H:217:LYS:HD3	1.88	0.56
4:L:90:GLN:HE22	4:L:93:SER:HB3	1.71	0.56
3:H:124:THR:HG22	3:H:155:PRO:HD3	1.87	0.55
3:H:12:VAL:HG22	3:H:16:ARG:HB2	1.90	0.54
3:H:91:THR:HG23	3:H:118:THR:HA	1.90	0.53
4:L:37:GLN:HB2	4:L:47:LEU:HD11	1.91	0.53
4:L:75:ILE:HD11	4:L:86:TYR:HE2	1.72	0.53
3:H:52:SER:HB3	3:H:57:ASN:HB2	1.90	0.52
3:H:35:HIS:HE1	3:H:106:TYR:HB3	1.76	0.51
3:H:34:MET:HB3	3:H:79:LEU:HD22	1.93	0.50
3:H:39:GLN:HB2	3:H:45:LEU:HD23	1.93	0.49
4:L:114:PRO:HB3	4:L:140:PHE:HB3	1.93	0.49
1:E:339:GLY:HA2	5:E:601:NAG:H82	1.94	0.49
1:E:393:THR:HA	1:E:522:ALA:HA	1.96	0.47
4:L:29:ILE:HG22	4:L:92:TYR:HB3	1.97	0.47
1:E:449:TYR:HB2	2:F:100:HIS:CD2	2.50	0.46
3:H:57:ASN:HB3	3:H:59:TYR:HE2	1.80	0.46
3:H:29:PHE:O	3:H:72:ARG:NH2	2.49	0.46
2:F:101:TYR:CE2	2:F:103:SER:HB2	2.50	0.46
2:F:31:THR:HA	2:F:98:GLN:HE21	1.80	0.46
4:L:109:ARG:HD2	4:L:172:SER:O	2.16	0.46
1:E:396:TYR:OH	6:E:602:CL:CL	2.72	0.45
1:E:357:ARG:HG3	1:E:396:TYR:HE1	1.82	0.45
1:E:357:ARG:NH2	6:E:602:CL:CL	2.79	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:E:385:THR:HG22	3:H:57:ASN:HB2	1.99	0.45
3:H:83:MET:HB3	3:H:86:LEU:HD21	1.99	0.44
1:E:339:GLY:CA	5:E:601:NAG:H82	2.47	0.44
2:F:83:MET:HE2	2:F:86:LEU:HD21	1.98	0.44
4:L:147:VAL:HG21	4:L:176:LEU:HD22	2.00	0.44
1:E:386:LYS:NZ	3:H:101:GLY:HA2	2.33	0.44
2:F:91:THR:HG23	2:F:124:THR:HA	1.98	0.43
3:H:12:VAL:HG11	3:H:86:LEU:HD13	1.99	0.43
1:E:396:TYR:HB2	1:E:514:SER:OG	2.19	0.43
1:E:366:SER:HA	1:E:369:TYR:CD2	2.53	0.43
1:E:429:PHE:HE1	1:E:514:SER:HB3	1.84	0.43
4:L:36:TYR:HE1	4:L:46:LEU:HD13	1.83	0.43
3:H:57:ASN:HB3	3:H:59:TYR:CE2	2.55	0.42
3:H:105:VAL:HG12	3:H:106:TYR:H	1.85	0.42
3:H:208:HIS:CD2	3:H:210:PRO:HD2	2.55	0.42
4:L:50:ALA:O	4:L:52:SER:N	2.47	0.42
3:H:159:THR:OG1	3:H:207:ASN:HB3	2.20	0.42
1:E:502:GLY:O	1:E:506:GLN:HG3	2.20	0.42
4:L:49:TYR:O	4:L:53:SER:HB2	2.20	0.41
3:H:32:TYR:CE1	3:H:98:LYS:HE3	2.56	0.41
4:L:148:GLN:HB3	4:L:196:GLU:HB3	2.03	0.40
3:H:35:HIS:ND1	3:H:108:PHE:HE1	2.18	0.40
3:H:4:LEU:HD23	3:H:24:ALA:HA	2.04	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	E	193/205 (94%)	178 (92%)	15 (8%)	0	100	100
2	F	123/151 (82%)	119 (97%)	4 (3%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
3	H	215/226 (95%)	203 (94%)	12 (6%)	0	100	100
4	L	213/215 (99%)	196 (92%)	17 (8%)	0	100	100
All	All	744/797 (93%)	696 (94%)	48 (6%)	0	100	100

There are no Ramachandran outliers to report.

### 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	E	167/177 (94%)	167 (100%)	0	100	100
2	F	99/120 (82%)	97 (98%)	2 (2%)	55	73
3	H	185/191 (97%)	182 (98%)	3 (2%)	62	78
4	L	188/188 (100%)	186 (99%)	2 (1%)	73	85
All	All	639/676 (94%)	632 (99%)	7 (1%)	73	85

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	F	45	ARG
2	F	72	ARG
3	H	50	VAL
3	H	105	VAL
3	H	212	ASN
4	L	109	ARG
4	L	143	ARG

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

### 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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 7 ligands modelled in this entry, 6 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
5	NAG	E	601	1	14,14,15	0.21	0	17,19,21	0.57	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	E	601	1	-	0/6/23/26	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	E	601	NAG	3	0

## 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	E	195/205 (95%)	0.59	15 (7%) 13 10	56, 81, 125, 181	0
2	F	125/151 (82%)	0.67	9 (7%) 15 12	54, 74, 109, 143	0
3	H	219/226 (96%)	0.54	11 (5%) 28 25	52, 74, 123, 159	0
4	L	215/215 (100%)	0.60	10 (4%) 31 28	55, 79, 109, 164	0
All	All	754/797 (94%)	0.59	45 (5%) 21 18	52, 78, 119, 181	0

All (45) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	H	1	GLU	5.5
3	H	192	VAL	5.1
2	F	13	GLN	4.9
4	L	215	CYS	4.2
2	F	28	THR	3.9
2	F	10	GLY	3.8
2	F	121	THR	3.7
4	L	36	TYR	3.6
1	E	446	GLY	3.4
3	H	218	ARG	3.3
2	F	92	ALA	3.1
1	E	340	GLU	2.9
1	E	423	TYR	2.9
1	E	368	LEU	2.8
2	F	78	THR	2.8
3	H	59	TYR	2.8
4	L	155	LEU	2.7
1	E	387	LEU	2.7
2	F	29	PHE	2.6
1	E	452	LEU	2.6
2	F	34	MET	2.6

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Mol	Chain	Res	Type	RSRZ
4	L	73	LEU	2.5
3	H	19	ARG	2.5
1	E	510	VAL	2.5
1	E	371	SER	2.5
1	E	389	ASP	2.5
1	E	441	LEU	2.4
1	E	519	HIS	2.4
1	E	503	VAL	2.4
3	H	104	TRP	2.3
2	F	88	TYR	2.3
1	E	486	PHE	2.2
4	L	159	ASN	2.2
4	L	47	LEU	2.2
3	H	222	LYS	2.1
4	L	24	ARG	2.1
1	E	515	PHE	2.1
4	L	149	TRP	2.1
3	H	223	SER	2.1
1	E	378	LYS	2.0
3	H	146	LEU	2.0
3	H	197	LEU	2.0
4	L	137	LEU	2.0
3	H	196	SER	2.0
4	L	136	LEU	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 monosaccharides 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, 95<sup>th</sup> 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
6	CL	F	201	1/1	0.61	0.15	77,77,77,77	0
5	NAG	E	601	14/15	0.71	0.35	107,147,160,171	0
6	CL	E	602	1/1	0.77	0.14	147,147,147,147	0
6	CL	H	301	1/1	0.87	0.11	80,80,80,80	0
6	CL	H	302	1/1	0.95	0.07	83,83,83,83	0
6	CL	L	301	1/1	0.95	0.10	79,79,79,79	0
7	MG	L	302	1/1	0.96	0.19	69,69,69,69	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.