



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 9, 2023 – 12:24 AM EDT

PDB ID : 7JXD  
Title : Mapping neutralizing and immunodominant sites on the SARS-CoV-2 spike receptor-binding domain by structure-guided high-resolution serology  
Authors : Park, Y.J.; Tortorici, M.A.; Walls, A.C.; Czudnochowski, N.; Seattle Structural Genomics Center for Infectious Disease (SSGCID); Snell, G.; Veesler, D.  
Deposited on : 2020-08-27  
Resolution : 2.50 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.

The types of validation reports are described at

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

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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  
Xtriage (Phenix) : 1.13  
EDS : 2.35.1  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.35.1

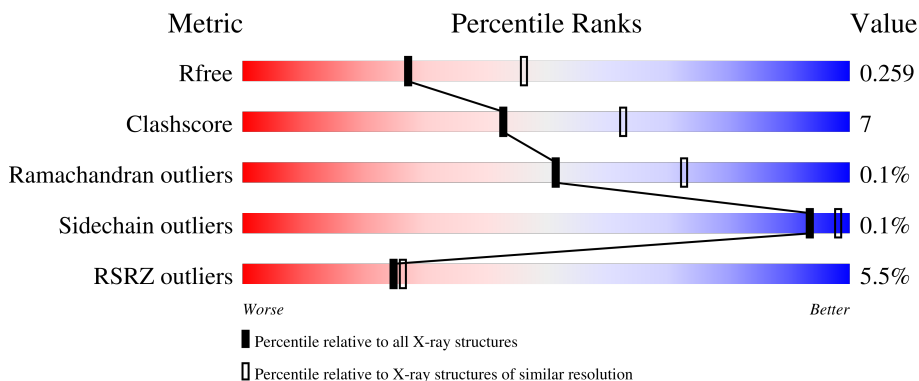
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.50 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	4661 (2.50-2.50)
Clashscore	141614	5346 (2.50-2.50)
Ramachandran outliers	138981	5231 (2.50-2.50)
Sidechain outliers	138945	5233 (2.50-2.50)
RSRZ outliers	127900	4559 (2.50-2.50)

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	A	228	 79% 13% 8%
1	C	228	 5% 73% 23% .
2	B	217	 5% 88% 11% .
2	D	217	 10% 82% 16% .

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 6527 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 S2A4 antigen-binding (Fab) fragment.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	210	Total 1602	C 1024	N 270	O 302	S 6	0	0	0
1	C	220	Total 1656	C 1052	N 279	O 319	S 6	0	0	0

- Molecule 2 is a protein called S2A4 antigen-binding (Fab) fragment.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	214	Total 1599	C 992	N 266	O 336	S 5	0	0	0
2	D	214	Total 1566	C 972	N 259	O 331	S 4	0	0	0

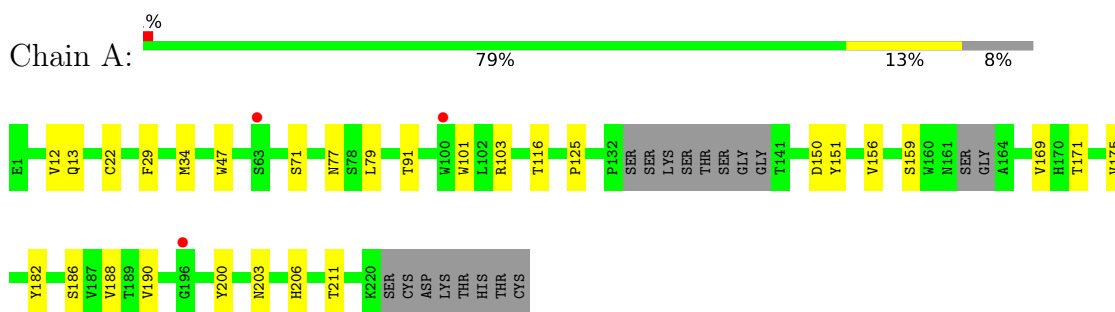
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	34	Total 34	O 34	0	0
3	B	27	Total 27	O 27	0	0
3	C	28	Total 28	O 28	0	0
3	D	15	Total 15	O 15	0	0

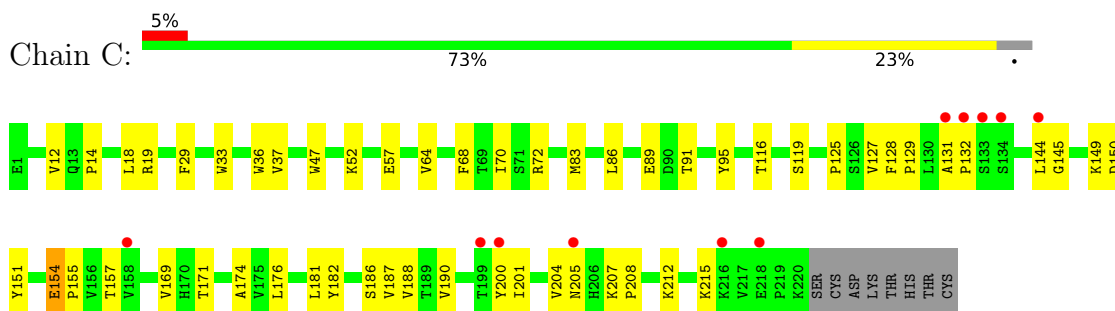
### 3 Residue-property plots [i](#)

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.

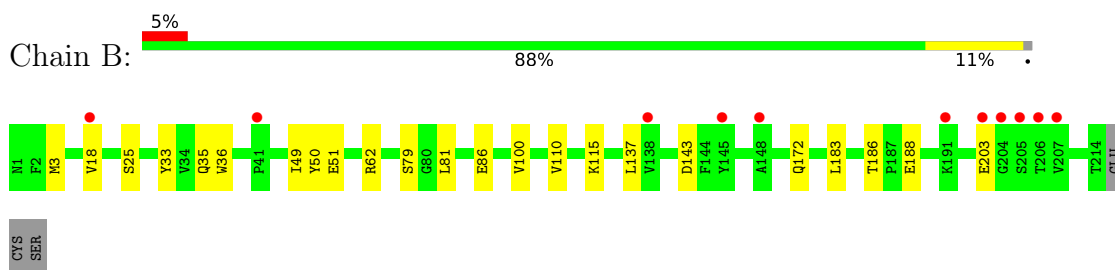
- Molecule 1: S2A4 antigen-binding (Fab) fragment



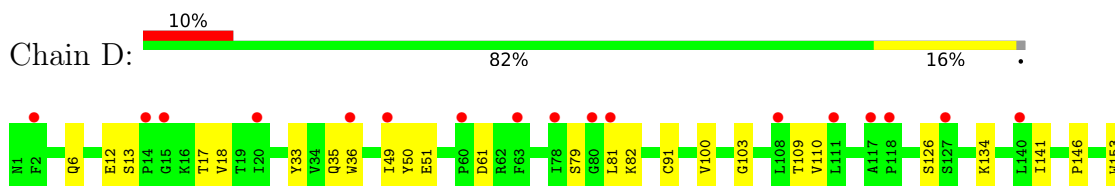
- Molecule 1: S2A4 antigen-binding (Fab) fragment

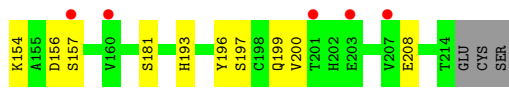


- Molecule 2: S2A4 antigen-binding (Fab) fragment



- Molecule 2: S2A4 antigen-binding (Fab) fragment





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	59.09Å 63.28Å 113.89Å 90.00° 103.97° 90.00°	Depositor
Resolution (Å)	46.51 – 2.50 46.52 – 2.50	Depositor EDS
% Data completeness (in resolution range)	86.7 (46.51-2.50) 86.8 (46.52-2.50)	Depositor EDS
$R_{merge}$	0.12	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.31 (at 2.51Å)	Xtrriage
Refinement program	PHENIX 1.18.2	Depositor
R, $R_{free}$	0.203 , 0.259 0.203 , 0.259	Depositor DCC
$R_{free}$ test set	1208 reflections (4.89%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	40.9	Xtrriage
Anisotropy	1.198	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 34.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.022 for h,-k,-h-l	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	6527	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	60.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.49% 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

### 5.1 Standard geometry

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	0.28	0/1643	0.50	0/2237
1	C	0.33	0/1699	0.55	0/2315
2	B	0.35	0/1638	0.54	0/2239
2	D	0.30	0/1605	0.51	0/2202
All	All	0.32	0/6585	0.52	0/8993

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	1602	0	1568	16	0
1	C	1656	0	1611	35	0
2	B	1599	0	1521	17	0
2	D	1566	0	1456	22	0
3	A	34	0	0	0	0
3	B	27	0	0	0	0
3	C	28	0	0	0	0
3	D	15	0	0	0	0
All	All	6527	0	6156	86	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 7.

All (86) 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:D:153:TRP:HE1	2:D:181:SER:HG	1.14	0.91
1:C:127:VAL:HG21	1:C:204:VAL:HG11	1.51	0.90
2:D:154:LYS:HB3	2:D:197:SER:HB2	1.63	0.78
1:C:37:VAL:HG12	1:C:47:TRP:HA	1.67	0.75
2:D:17:THR:HG22	2:D:79:SER:HA	1.69	0.74
2:D:6:GLN:HE21	2:D:103:GLY:HA3	1.58	0.69
2:B:143:ASP:H	2:B:172:GLN:HE22	1.42	0.68
2:D:36:TRP:HB2	2:D:49:ILE:HB	1.77	0.66
2:B:115:LYS:HD2	2:B:203:GLU:HG3	1.80	0.63
2:B:143:ASP:H	2:B:172:GLN:NE2	1.97	0.61
1:A:91:THR:HG23	1:A:116:THR:HA	1.83	0.61
2:B:3:MET:HB3	2:B:25:SER:HB3	1.83	0.60
1:C:171:THR:HG23	1:C:186:SER:HB2	1.83	0.59
2:B:186:THR:HB	2:B:188:GLU:OE1	2.02	0.59
2:D:199:GLN:HG2	2:D:208:GLU:HG3	1.85	0.57
2:D:35:GLN:HG3	2:D:50:TYR:HA	1.86	0.57
1:A:171:THR:HG23	1:A:186:SER:HB2	1.85	0.57
1:A:34:MET:HB3	1:A:79:LEU:HD22	1.86	0.56
1:A:47:TRP:CG	2:B:100:VAL:HB	2.41	0.55
1:A:159:SER:O	1:A:203:ASN:N	2.35	0.55
1:C:37:VAL:HG23	1:C:95:TYR:HB2	1.89	0.55
1:C:127:VAL:CG2	1:C:204:VAL:HG11	2.31	0.55
2:D:109:THR:HG21	2:D:146:PRO:HB3	1.88	0.54
2:D:6:GLN:NE2	2:D:91:CYS:H	2.05	0.54
2:B:18:VAL:HG13	2:B:81:LEU:HD11	1.92	0.52
2:B:35:GLN:HG3	2:B:50:TYR:HA	1.91	0.52
1:C:47:TRP:CG	2:D:100:VAL:HB	2.45	0.52
1:C:154:GLU:HG2	1:C:155:PRO:HA	1.92	0.52
1:C:18:LEU:HD23	1:C:19:ARG:N	2.24	0.52
1:C:154:GLU:OE2	1:C:174:ALA:HB3	2.09	0.52
2:B:36:TRP:HB2	2:B:49:ILE:HB	1.93	0.51
2:D:18:VAL:HG23	2:D:81:LEU:HD11	1.91	0.51
1:A:125:PRO:HD2	1:A:211:THR:HG21	1.93	0.51
2:B:62:ARG:HB3	2:B:79:SER:O	2.11	0.51
1:A:169:VAL:HG22	1:A:188:VAL:HG12	1.94	0.50
1:C:201:ILE:HA	1:C:215:LYS:O	2.12	0.50
1:C:132:PRO:HG3	1:C:144:LEU:HB3	1.94	0.50
2:D:82:LYS:O	2:D:110:VAL:HG21	2.12	0.49
1:C:125:PRO:HB3	1:C:151:TYR:HB3	1.94	0.49
1:C:205:ASN:OD1	1:C:212:LYS:HG2	2.13	0.48

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:D:6:GLN:HE22	2:D:91:CYS:H	1.62	0.48
1:A:125:PRO:HB3	1:A:151:TYR:HB3	1.96	0.47
1:A:12:VAL:HG12	1:A:13:GLN:O	2.15	0.47
1:C:64:VAL:HB	1:C:68:PHE:CG	2.49	0.47
1:C:12:VAL:HG11	1:C:86:LEU:HD12	1.96	0.47
1:C:83:MET:HB3	1:C:86:LEU:HD21	1.96	0.47
1:C:127:VAL:C	1:C:128:PHE:HD2	2.17	0.47
1:C:36:TRP:HD1	1:C:70:ILE:HD12	1.79	0.46
2:B:115:LYS:CD	2:B:203:GLU:HG3	2.46	0.46
2:B:50:TYR:HD1	2:B:51:GLU:HG3	1.81	0.45
1:C:149:LYS:NZ	2:D:134:LYS:HE2	2.32	0.45
2:B:137:LEU:HB2	2:B:183:LEU:HB3	1.98	0.45
1:C:150:ASP:HB3	1:C:181:LEU:HD13	1.99	0.45
1:C:190:VAL:HG11	1:C:200:TYR:CE2	2.51	0.45
1:C:157:THR:O	1:C:204:VAL:HA	2.17	0.45
1:C:207:LYS:N	1:C:208:PRO:HD2	2.32	0.45
1:C:176:LEU:HB2	1:C:182:TYR:HE1	1.81	0.45
1:C:52:LYS:HB2	1:C:57:GLU:HB2	1.99	0.44
2:D:141:ILE:HG12	2:D:200:VAL:HG21	1.98	0.44
2:B:33:TYR:HB3	2:B:51:GLU:HA	2.00	0.44
1:A:101:TRP:CZ3	1:A:103:ARG:HB2	2.54	0.43
1:C:145:GLY:HA3	1:C:187:VAL:HG12	2.01	0.43
1:C:29:PHE:O	1:C:72:ARG:NH2	2.52	0.43
1:C:89:GLU:OE1	1:C:89:GLU:N	2.47	0.43
1:C:129:PRO:HD2	2:D:126:SER:OG	2.18	0.43
2:D:12:GLU:OE1	2:D:13:SER:N	2.52	0.42
2:D:61:ASP:OD1	2:D:61:ASP:N	2.52	0.42
1:A:22:CYS:HB3	1:A:79:LEU:HB3	2.00	0.42
1:A:190:VAL:HG11	1:A:200:TYR:CZ	2.55	0.42
1:A:71:SER:O	1:A:79:LEU:HD12	2.20	0.42
2:D:36:TRP:CZ3	2:D:91:CYS:HB3	2.55	0.42
2:D:156:ASP:O	2:D:157:SER:OG	2.32	0.42
1:C:131:ALA:HA	1:C:132:PRO:HD3	1.92	0.42
2:B:143:ASP:N	2:B:172:GLN:HE22	2.14	0.41
2:B:188:GLU:H	2:B:188:GLU:CD	2.23	0.41
2:D:193:HIS:ND1	2:D:196:TYR:OH	2.47	0.41
1:C:169:VAL:HG22	1:C:188:VAL:HB	2.01	0.41
1:C:33:TRP:CZ2	1:C:52:LYS:HG3	2.56	0.41
1:A:29:PHE:HB3	1:A:77:ASN:HD22	1.86	0.41
2:D:33:TYR:HB3	2:D:51:GLU:HA	2.03	0.41
2:B:86:GLU:HG3	2:B:110:VAL:H	1.85	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:14:PRO:HD2	1:C:119:SER:HB3	2.04	0.40
1:C:91:THR:HG23	1:C:116:THR:HA	2.03	0.40
1:A:175:VAL:O	1:A:182:TYR:HA	2.20	0.40
1:C:12:VAL:CG2	1:C:18:LEU:HD12	2.51	0.40
1:A:156:VAL:HG23	1:A:206:HIS:HD2	1.87	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	204/228 (90%)	198 (97%)	5 (2%)	1 (0%)	29	48
1	C	218/228 (96%)	208 (95%)	10 (5%)	0	100	100
2	B	212/217 (98%)	206 (97%)	6 (3%)	0	100	100
2	D	212/217 (98%)	199 (94%)	13 (6%)	0	100	100
All	All	846/890 (95%)	811 (96%)	34 (4%)	1 (0%)	51	73

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	150	ASP

### 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	176/193 (91%)	176 (100%)	0	100	100
1	C	182/193 (94%)	181 (100%)	1 (0%)	88	96
2	B	184/188 (98%)	184 (100%)	0	100	100
2	D	176/188 (94%)	176 (100%)	0	100	100
All	All	718/762 (94%)	717 (100%)	1 (0%)	93	98

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	154	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	77	ASN
2	B	172	GLN
2	D	6	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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

There are no ligands in this entry.

## 5.7 Other polymers [i](#)

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, 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	A	210/228 (92%)	0.35	3 (1%) 75 77	42, 52, 74, 88	0
1	C	220/228 (96%)	0.53	11 (5%) 28 30	43, 59, 78, 115	0
2	B	214/217 (98%)	0.43	11 (5%) 28 29	44, 54, 79, 110	0
2	D	214/217 (98%)	0.60	22 (10%) 6 6	50, 69, 99, 115	0
All	All	858/890 (96%)	0.48	47 (5%) 25 26	42, 58, 90, 115	0

All (47) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	133	SER	4.9
1	C	200	TYR	4.4
1	C	131	ALA	4.1
2	B	205	SER	3.8
1	C	132	PRO	3.7
2	D	127	SER	3.6
1	C	218	GLU	3.4
2	D	63	PHE	3.4
2	D	60	PRO	3.4
2	D	117	ALA	3.3
2	D	15	GLY	3.3
2	B	191	LYS	3.3
1	C	144	LEU	3.2
2	D	118	PRO	3.1
1	A	100	TRP	3.1
2	D	2	PHE	3.0
2	B	204	GLY	3.0
1	C	216	LYS	3.0
2	D	111	LEU	3.0
2	D	81	LEU	2.8
2	D	160	VAL	2.8

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Mol	Chain	Res	Type	RSRZ
2	D	207	VAL	2.7
2	D	49	ILE	2.7
2	B	138	VAL	2.7
2	B	148	ALA	2.7
2	B	203	GLU	2.6
2	B	18	VAL	2.6
2	B	145	TYR	2.5
1	A	63	SER	2.5
2	D	203	GLU	2.4
1	A	196	GLY	2.3
2	D	140	LEU	2.3
1	C	158	VAL	2.3
1	C	199	THR	2.3
2	D	80	GLY	2.3
2	D	14	PRO	2.2
2	D	20	ILE	2.2
1	C	205	ASN	2.2
2	B	206	THR	2.1
1	C	134	SER	2.1
2	B	41	PRO	2.1
2	D	201	THR	2.1
2	B	207	VAL	2.0
2	D	108	LEU	2.0
2	D	36	TRP	2.0
2	D	157	SER	2.0
2	D	78	ILE	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 [\(i\)](#)

There are no ligands in this entry.

## 6.5 Other polymers [i](#)

There are no such residues in this entry.