



# Full wwPDB X-ray Structure Validation Report ⓘ

Sep 9, 2023 – 10:17 PM EDT

PDB ID : 4HI3  
Title : Crystal structure of dimeric R298A mutant of SARS coronavirus main protease  
Authors : Wu, C.-G.; Chou, C.-Y.  
Deposited on : 2012-10-11  
Resolution : 2.09 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

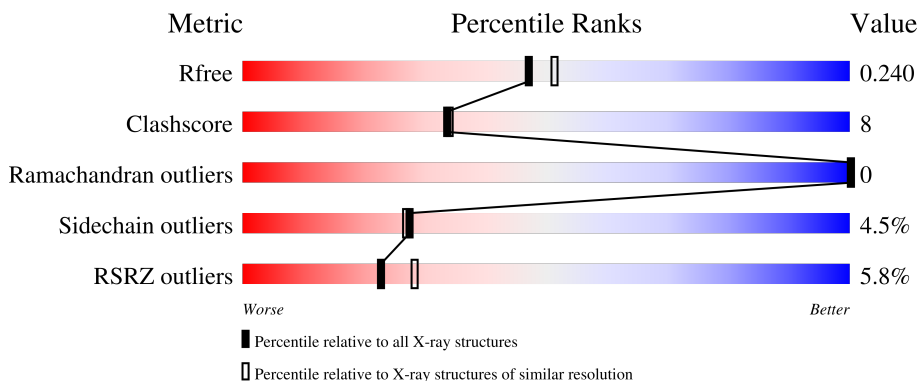
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.09 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	5197 (2.10-2.10)
Clashscore	141614	5710 (2.10-2.10)
Ramachandran outliers	138981	5647 (2.10-2.10)
Sidechain outliers	138945	5648 (2.10-2.10)
RSRZ outliers	127900	5083 (2.10-2.10)

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	315	 6% 78% 16% • 5%
1	B	315	 5% 77% 17% • •

## 2 Entry composition i

There are 2 unique types of molecules in this entry. The entry contains 4912 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 3C-like proteinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	300	2320	1468	395	435	22	0	0	0
1	B	301	2326	1471	396	437	22	0	0	0

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	0	MET	-	initiating methionine	UNP P0C6U8
A	298	ALA	ARG	engineered mutation	UNP P0C6U8
A	307	LEU	-	expression tag	UNP P0C6U8
A	308	GLU	-	expression tag	UNP P0C6U8
A	309	HIS	-	expression tag	UNP P0C6U8
A	310	HIS	-	expression tag	UNP P0C6U8
A	311	HIS	-	expression tag	UNP P0C6U8
A	312	HIS	-	expression tag	UNP P0C6U8
A	313	HIS	-	expression tag	UNP P0C6U8
A	314	HIS	-	expression tag	UNP P0C6U8
B	0	MET	-	initiating methionine	UNP P0C6U8
B	298	ALA	ARG	engineered mutation	UNP P0C6U8
B	307	LEU	-	expression tag	UNP P0C6U8
B	308	GLU	-	expression tag	UNP P0C6U8
B	309	HIS	-	expression tag	UNP P0C6U8
B	310	HIS	-	expression tag	UNP P0C6U8
B	311	HIS	-	expression tag	UNP P0C6U8
B	312	HIS	-	expression tag	UNP P0C6U8
B	313	HIS	-	expression tag	UNP P0C6U8
B	314	HIS	-	expression tag	UNP P0C6U8

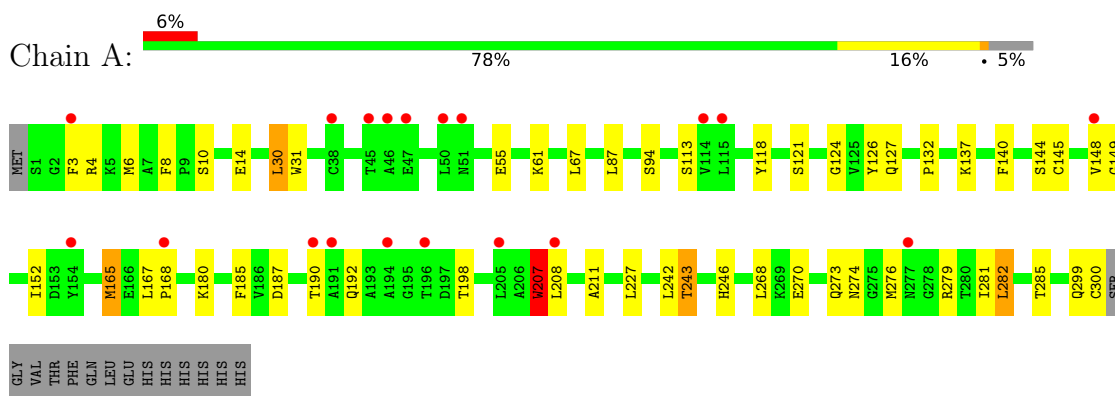
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	134	Total 134	O 134	0	0
2	B	132	Total 132	O 132	0	0

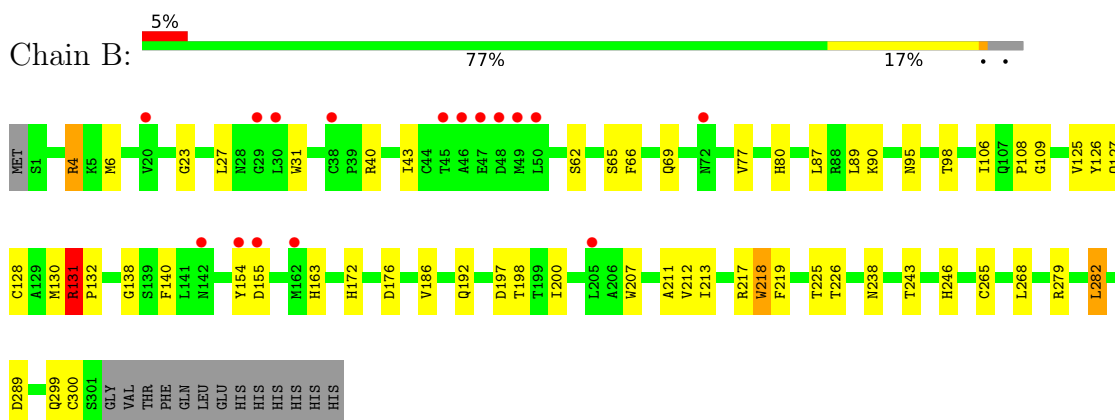
### 3 Residue-property plots

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



- Molecule 1: 3C-like proteinase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	55.04Å 59.44Å 59.82Å 71.29° 73.40° 72.31°	Depositor
Resolution (Å)	30.00 – 2.09 24.15 – 2.09	Depositor EDS
% Data completeness (in resolution range)	94.7 (30.00-2.09) 94.8 (24.15-2.09)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.52 (at 2.10Å)	Xtrriage
Refinement program	REFMAC 5.6.0117	Depositor
R, $R_{free}$	0.190 , 0.241 0.189 , 0.240	Depositor DCC
$R_{free}$ test set	1878 reflections (4.98%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	36.7	Xtrriage
Anisotropy	0.309	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 37.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.016 for -h,-l,-k	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	4912	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	45.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.21% 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](#)

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	0.55	2/2372 (0.1%)	0.64	0/3224
1	B	0.57	3/2378 (0.1%)	0.66	1/3232 (0.0%)
All	All	0.56	5/4750 (0.1%)	0.65	1/6456 (0.0%)

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	218	TRP	CD2-CE2	5.42	1.47	1.41
1	A	207	TRP	CD2-CE2	5.30	1.47	1.41
1	B	207	TRP	CD2-CE2	5.21	1.47	1.41
1	A	31	TRP	CD2-CE2	5.15	1.47	1.41
1	B	31	TRP	CD2-CE2	5.10	1.47	1.41

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	131	ARG	NE-CZ-NH2	-6.00	117.30	120.30

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	A	2320	0	2273	38	0
1	B	2326	0	2278	45	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	A	134	0	0	15	0
2	B	132	0	0	13	0
All	All	4912	0	4551	78	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 8.

All (78) 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:219:PHE:HZ	2:B:509:HOH:O	1.38	1.05
1:B:212:VAL:HG23	2:B:509:HOH:O	1.58	1.02
1:A:6:MET:HB3	2:B:479:HOH:O	1.62	0.99
1:B:225:THR:HB	2:B:442:HOH:O	1.66	0.95
1:A:300:CYS:HB3	2:A:505:HOH:O	1.69	0.91
1:B:154:TYR:HB2	2:B:420:HOH:O	1.76	0.85
1:B:219:PHE:CZ	2:B:509:HOH:O	2.20	0.75
1:B:109:GLY:HA2	1:B:200:ILE:HD13	1.68	0.75
1:A:207:TRP:HE3	2:A:512:HOH:O	1.71	0.73
1:A:207:TRP:CE3	2:A:512:HOH:O	2.42	0.73
1:B:186:VAL:H	1:B:192:GLN:HE22	1.37	0.72
1:A:137:LYS:O	1:B:4:ARG:NH1	2.25	0.70
1:B:66:PHE:HB2	1:B:77:VAL:HG21	1.74	0.70
1:A:4:ARG:H	1:A:299:GLN:HE22	1.41	0.69
1:A:124:GLY:HA3	1:B:6:MET:HE3	1.76	0.67
1:B:4:ARG:H	1:B:299:GLN:HE22	1.43	0.67
1:A:145:CYS:SG	2:A:506:HOH:O	2.53	0.67
1:B:69:GLN:HB3	2:B:459:HOH:O	1.97	0.63
1:A:243:THR:HG22	1:A:246:HIS:H	1.65	0.62
1:A:140:PHE:HA	2:A:510:HOH:O	2.00	0.61
1:B:225:THR:HG22	1:B:226:THR:O	2.04	0.56
1:A:270:GLU:HG3	1:A:274:ASN:HD21	1.71	0.54
1:B:131:ARG:CD	1:B:197:ASP:OD1	2.55	0.54
1:B:23:GLY:HA3	2:B:422:HOH:O	2.07	0.53
1:A:126:TYR:CD1	1:B:4:ARG:HG2	2.44	0.53
1:A:180:LYS:HD3	2:A:525:HOH:O	2.09	0.52
1:A:167:LEU:HB3	1:A:168:PRO:CD	2.40	0.52
1:A:30:LEU:HG	1:A:148:VAL:HG11	1.91	0.51
2:A:479:HOH:O	1:B:138:GLY:HA2	2.11	0.51
1:B:131:ARG:HD2	1:B:197:ASP:OD1	2.11	0.51
1:A:4:ARG:HD2	1:B:126:TYR:CD1	2.47	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:90:LYS:HD2	2:B:429:HOH:O	2.12	0.49
1:A:3:PHE:HZ	1:A:300:CYS:SG	2.36	0.49
1:A:208:LEU:HD23	2:A:512:HOH:O	2.13	0.48
1:B:4:ARG:N	1:B:299:GLN:HE22	2.11	0.48
1:B:131:ARG:HD3	1:B:197:ASP:OD1	2.14	0.48
1:A:10:SER:O	1:A:14:GLU:HG3	2.13	0.48
1:A:3:PHE:CZ	1:A:300:CYS:SG	3.07	0.48
1:B:4:ARG:NH2	2:B:528:HOH:O	2.47	0.47
1:A:132:PRO:HG2	1:A:198:THR:O	2.14	0.47
1:A:165:MET:HE1	1:A:187:ASP:HA	1.95	0.47
1:B:213:ILE:HG21	1:B:300:CYS:HB3	1.96	0.47
1:A:279:ARG:HB3	2:A:432:HOH:O	2.15	0.47
1:A:124:GLY:HA3	1:B:6:MET:CE	2.45	0.46
1:B:131:ARG:NH2	1:B:289:ASP:OD2	2.37	0.46
1:A:55:GLU:HG2	2:A:419:HOH:O	2.15	0.46
2:A:479:HOH:O	1:B:126:TYR:HE1	1.98	0.46
1:A:227:LEU:HD11	1:A:242:LEU:HB3	1.97	0.46
1:B:140:PHE:HD1	1:B:172:HIS:CG	2.35	0.45
1:B:125:VAL:N	2:B:479:HOH:O	2.49	0.45
1:B:176:ASP:HB2	2:B:529:HOH:O	2.16	0.45
1:B:198:THR:HG22	1:B:238:ASN:OD1	2.17	0.45
1:A:8:PHE:HB3	1:A:152:ILE:HD12	1.99	0.45
1:B:106:ILE:HD13	1:B:130:MET:HB2	1.98	0.45
1:B:95:ASN:HB3	1:B:98:THR:OG1	2.17	0.44
1:A:190:THR:N	2:A:446:HOH:O	2.50	0.44
1:B:108:PRO:HB3	1:B:132:PRO:HA	2.00	0.44
1:A:211:ALA:HA	1:A:282:LEU:HD13	1.99	0.44
1:B:243:THR:H	1:B:246:HIS:CD2	2.36	0.44
2:A:479:HOH:O	1:B:128:CYS:HB3	2.18	0.44
1:A:276:MET:O	1:A:279:ARG:HD3	2.18	0.43
1:B:225:THR:HG22	1:B:226:THR:N	2.33	0.43
1:B:163:HIS:CE1	1:B:172:HIS:HB3	2.53	0.43
1:A:61:LYS:HA	1:A:61:LYS:HD3	1.84	0.43
1:B:40:ARG:O	1:B:43:ILE:HG12	2.19	0.43
1:B:80:HIS:HB3	1:B:89:LEU:HD23	2.01	0.42
1:B:140:PHE:HD1	1:B:172:HIS:CD2	2.36	0.42
1:B:211:ALA:HB2	1:B:282:LEU:HD22	2.00	0.42
1:A:185:PHE:HA	1:A:192:GLN:OE1	2.20	0.42
1:A:113:SER:O	1:A:149:GLY:HA2	2.20	0.42
1:B:218:TRP:CZ2	1:B:279:ARG:HB2	2.54	0.42
1:A:118:TYR:CE1	1:A:144:SER:HB3	2.55	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:106:ILE:H	1:B:106:ILE:HG13	1.71	0.41
1:A:276:MET:HE3	1:A:285:THR:O	2.20	0.41
1:B:265:CYS:HB2	2:B:442:HOH:O	2.21	0.41
1:A:270:GLU:HG3	1:A:274:ASN:ND2	2.35	0.41
1:A:281:ILE:HG12	2:A:514:HOH:O	2.20	0.40
1:A:61:LYS:HE2	2:A:435:HOH:O	2.21	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	298/315 (95%)	285 (96%)	13 (4%)	0	100	100
1	B	299/315 (95%)	292 (98%)	7 (2%)	0	100	100
All	All	597/630 (95%)	577 (97%)	20 (3%)	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	A	257/271 (95%)	245 (95%)	12 (5%)	26	25
1	B	258/271 (95%)	247 (96%)	11 (4%)	29	29

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
All	All	515/542 (95%)	492 (96%)	23 (4%)	27 27

All (23) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	30	LEU
1	A	67	LEU
1	A	87	LEU
1	A	94	SER
1	A	121	SER
1	A	127	GLN
1	A	165	MET
1	A	207	TRP
1	A	243	THR
1	A	268	LEU
1	A	273	GLN
1	A	282	LEU
1	B	4	ARG
1	B	27	LEU
1	B	62	SER
1	B	65	SER
1	B	87	LEU
1	B	127	GLN
1	B	131	ARG
1	B	155	ASP
1	B	217	ARG
1	B	268	LEU
1	B	282	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (12) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	19	GLN
1	A	69	GLN
1	A	246	HIS
1	A	273	GLN
1	A	274	ASN
1	A	299	GLN
1	B	69	GLN
1	B	127	GLN
1	B	192	GLN

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Mol	Chain	Res	Type
1	B	246	HIS
1	B	274	ASN
1	B	299	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 [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	A	300/315 (95%)	0.22	19 (6%) 20 24	28, 43, 74, 89	0
1	B	301/315 (95%)	0.19	16 (5%) 26 32	26, 42, 66, 86	0
All	All	601/630 (95%)	0.20	35 (5%) 23 28	26, 42, 71, 89	0

All (35) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	50	LEU	7.1
1	B	154	TYR	4.5
1	A	154	TYR	4.4
1	B	155	ASP	4.4
1	B	49	MET	4.0
1	B	72	ASN	3.9
1	B	142	ASN	3.8
1	B	47	GLU	3.4
1	A	196	THR	3.3
1	A	115	LEU	3.2
1	A	46	ALA	3.1
1	B	38	CYS	3.1
1	A	194	ALA	3.1
1	A	51	ASN	3.0
1	B	46	ALA	3.0
1	B	45	THR	2.9
1	A	277	ASN	2.9
1	A	50	LEU	2.9
1	A	190	THR	2.8
1	A	148	VAL	2.8
1	A	45	THR	2.7
1	B	205	LEU	2.7
1	A	3	PHE	2.6
1	B	48	ASP	2.4

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Mol	Chain	Res	Type	RSRZ
1	A	47	GLU	2.4
1	B	29	GLY	2.4
1	A	205	LEU	2.3
1	B	20	VAL	2.3
1	A	38	CYS	2.2
1	A	168	PRO	2.2
1	A	208	LEU	2.2
1	A	191	ALA	2.1
1	A	114	VAL	2.1
1	B	30	LEU	2.1
1	B	162	MET	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.