



# Full wwPDB X-ray Structure Validation Report ⓘ

Dec 10, 2023 – 05:25 pm GMT

PDB ID : 2IX2  
Title : Crystal structure of the heterotrimeric PCNA from *Sulfolobus solfataricus*  
Authors : Williams, G.J.; Johnson, K.; McMahon, S.A.; Carter, L.; Oke, M.; Liu, H.; Taylor, G.L.; White, M.F.; Naismith, J.H.  
Deposited on : 2006-07-05  
Resolution : 2.20 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 : 2.36  
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) : 2.36

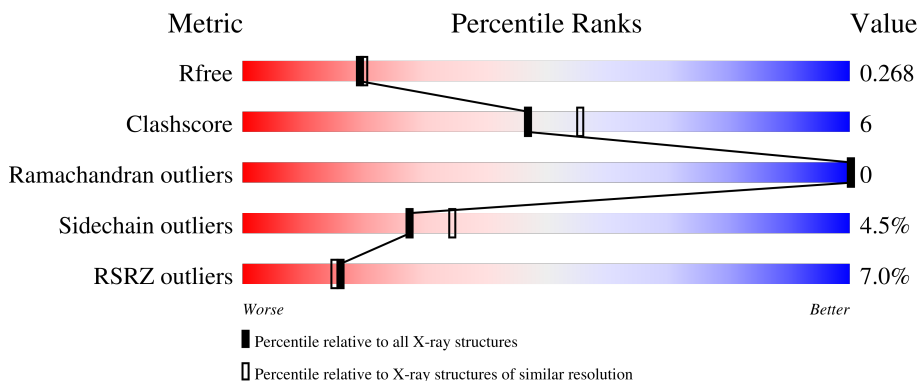
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.20 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	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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	249	
2	B	245	
3	C	259	

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 5701 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 DNA POLYMERASE SLIDING CLAMP B.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	226	1738	1115	277	338	8	0	0	0

- Molecule 2 is a protein called DNA POLYMERASE SLIDING CLAMP C.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	245	1926	1238	301	383	4	0	0	0

- Molecule 3 is a protein called DNA POLYMERASE SLIDING CLAMP A.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	C	241	1917	1224	310	379	4	0	0	0

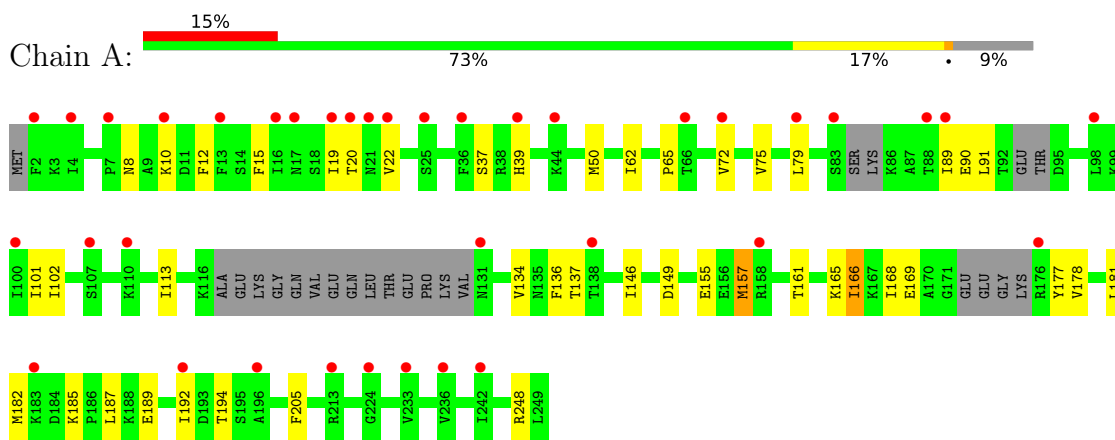
- Molecule 4 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	8	Total 8 8	0	0
4	B	45	Total 45 45	0	0
4	C	67	Total 67 67	0	0

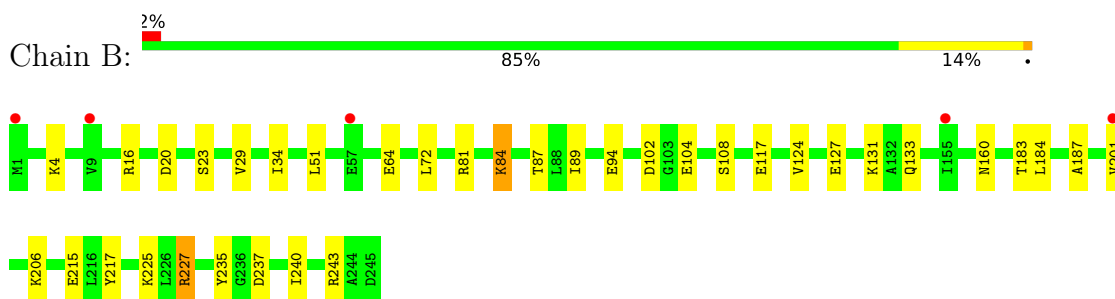
### 3 Residue-property plots [i](#)

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.

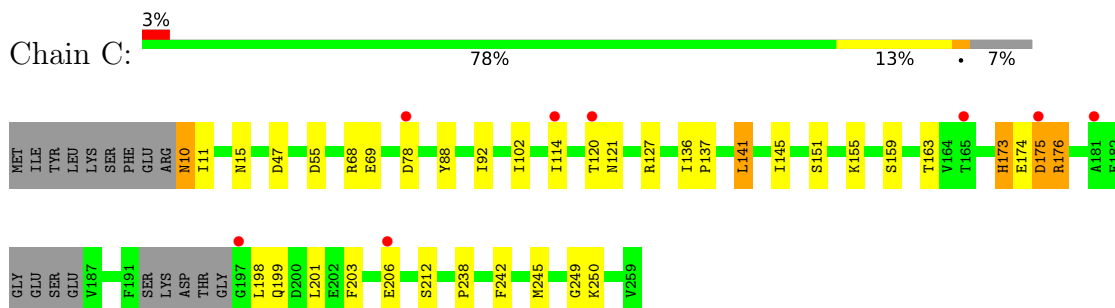
- Molecule 1: DNA POLYMERASE SLIDING CLAMP B



- Molecule 2: DNA POLYMERASE SLIDING CLAMP C



- Molecule 3: DNA POLYMERASE SLIDING CLAMP A



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	44.81Å 78.80Å 125.61Å 90.00° 100.51° 90.00°	Depositor
Resolution (Å)	48.62 – 2.20 48.60 – 2.20	Depositor EDS
% Data completeness (in resolution range)	91.2 (48.62-2.20) 91.2 (48.60-2.20)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.57 (at 2.20Å)	Xtrriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.217 , 0.273 0.217 , 0.268	Depositor DCC
$R_{free}$ test set	2026 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	47.7	Xtrriage
Anisotropy	0.137	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 64.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.045 for h,-k,-h-l	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	5701	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	55.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.86% 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	0.43	0/1761	0.56	0/2370
2	B	0.76	3/1961 (0.2%)	0.70	1/2653 (0.0%)
3	C	0.93	7/1941 (0.4%)	0.89	3/2615 (0.1%)
All	All	0.74	10/5663 (0.2%)	0.74	4/7638 (0.1%)

All (10) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	176	ARG	NE-CZ	15.18	1.52	1.33
3	C	175	ASP	CG-OD1	13.87	1.57	1.25
2	B	84	LYS	CE-NZ	13.31	1.82	1.49
3	C	69	GLU	CD-OE1	12.49	1.39	1.25
2	B	84	LYS	CD-CE	9.47	1.75	1.51
3	C	176	ARG	CZ-NH2	8.30	1.43	1.33
3	C	69	GLU	CD-OE2	8.20	1.34	1.25
3	C	176	ARG	CD-NE	6.89	1.58	1.46
2	B	104	GLU	CD-OE2	5.30	1.31	1.25
3	C	173	HIS	CE1-NE2	5.17	1.44	1.32

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	176	ARG	NE-CZ-NH2	-25.73	107.44	120.30
3	C	176	ARG	CD-NE-CZ	-9.49	110.31	123.60
3	C	176	ARG	NH1-CZ-NH2	8.37	128.61	119.40
2	B	84	LYS	CD-CE-NZ	-8.15	92.96	111.70

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	1738	0	1769	25	0
2	B	1926	0	1904	28	0
3	C	1917	0	1935	23	0
4	A	8	0	0	0	0
4	B	45	0	0	3	0
4	C	67	0	0	1	0
All	All	5701	0	5608	69	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 6.

All (69) 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:84:LYS:CD	2:B:84:LYS:CE	1.74	1.54
2:B:84:LYS:CE	2:B:84:LYS:NZ	1.82	1.42
1:A:20:THR:HG21	1:A:72:VAL:HG11	1.53	0.88
2:B:183:THR:HG21	3:C:120:THR:HG23	1.56	0.87
2:B:183:THR:HG21	3:C:120:THR:CG2	2.09	0.82
2:B:84:LYS:CE	2:B:84:LYS:CG	2.59	0.81
3:C:155:LYS:NZ	4:C:2055:HOH:O	2.23	0.72
2:B:133:GLN:HG2	2:B:215:GLU:HG2	1.74	0.70
2:B:227:ARG:HD3	2:B:237:ASP:OD1	1.92	0.69
1:A:37:SER:HB3	1:A:50:MET:HG2	1.75	0.69
3:C:141:LEU:HD11	3:C:238:PRO:HD2	1.75	0.68
1:A:169:GLU:HG2	1:A:178:VAL:HG12	1.76	0.67
1:A:8:ASN:HD21	1:A:10:LYS:HB3	1.59	0.67
2:B:84:LYS:CD	2:B:84:LYS:NZ	2.58	0.67
3:C:10:ASN:N	3:C:10:ASN:OD1	2.28	0.66
2:B:183:THR:CG2	3:C:120:THR:HG23	2.25	0.66
1:A:149:ASP:OD1	2:B:81:ARG:HD3	1.97	0.64
1:A:20:THR:HG21	1:A:72:VAL:CG1	2.28	0.62
2:B:225:LYS:NZ	4:B:2037:HOH:O	2.32	0.62
1:A:75:VAL:HG23	1:A:113:ILE:HD13	1.80	0.62
1:A:161:THR:HG23	1:A:192:ILE:HD13	1.81	0.61

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:C:173:HIS:HA	3:C:206:GLU:HG2	1.81	0.61
2:B:227:ARG:CD	2:B:237:ASP:OD1	2.48	0.61
2:B:16:ARG:HD2	2:B:206:LYS:HD3	1.83	0.59
2:B:201:VAL:HG22	2:B:240:ILE:HD12	1.85	0.57
1:A:137:THR:HB	1:A:189:GLU:HB3	1.85	0.57
1:A:12:PHE:HD2	1:A:89:ILE:HD13	1.69	0.56
3:C:198:LEU:HD21	3:C:201:LEU:HD13	1.88	0.55
3:C:245:MET:HE3	3:C:249:GLY:HA3	1.90	0.53
3:C:88:TYR:CE2	3:C:92:ILE:HD11	2.43	0.53
1:A:90:GLU:HB2	1:A:101:ILE:HB	1.89	0.52
1:A:79:LEU:HD13	1:A:102:ILE:HD13	1.91	0.52
1:A:157:MET:HE1	1:A:205:PHE:CG	2.45	0.51
2:B:183:THR:CG2	3:C:120:THR:CG2	2.86	0.51
2:B:183:THR:HG21	3:C:120:THR:HG21	1.90	0.50
2:B:131:LYS:HG2	2:B:217:TYR:CD1	2.46	0.50
2:B:160:ASN:ND2	4:B:2024:HOH:O	2.47	0.48
2:B:243:ARG:NH1	4:B:2043:HOH:O	2.45	0.48
1:A:136:PHE:CD1	1:A:166:ILE:HD12	2.48	0.47
2:B:184:LEU:HD13	2:B:187:ALA:HB2	1.97	0.47
1:A:134:VAL:HG13	1:A:192:ILE:HG12	1.95	0.47
3:C:175:ASP:OD2	3:C:176:ARG:HD3	2.14	0.47
1:A:161:THR:HG21	1:A:192:ILE:HG21	1.95	0.47
3:C:249:GLY:O	3:C:250:LYS:HD3	2.15	0.46
2:B:29:VAL:HG22	2:B:34:ILE:HG12	1.99	0.45
3:C:242:PHE:HE1	3:C:250:LYS:HB3	1.82	0.45
1:A:157:MET:HB3	1:A:157:MET:HE3	1.55	0.45
2:B:127:GLU:OE1	2:B:127:GLU:HA	2.16	0.45
2:B:227:ARG:HD2	2:B:235:TYR:HB2	2.00	0.44
3:C:136:ILE:HA	3:C:137:PRO:HD3	1.88	0.43
3:C:47:ASP:HA	3:C:68:ARG:HD2	2.00	0.43
2:B:20:ASP:OD2	2:B:206:LYS:NZ	2.34	0.43
3:C:159:SER:O	3:C:163:THR:HG23	2.18	0.42
1:A:182:MET:HG3	1:A:185:LYS:HB3	2.00	0.42
2:B:131:LYS:HG2	2:B:217:TYR:HD1	1.83	0.42
1:A:165:LYS:HB3	1:A:182:MET:HB3	2.02	0.42
1:A:181:LEU:HD23	1:A:187:LEU:HD21	2.01	0.42
1:A:146:ILE:HG21	1:A:168:ILE:HD13	2.02	0.42
1:A:22:VAL:HB	1:A:39:HIS:CE1	2.55	0.41
3:C:145:ILE:HD11	3:C:201:LEU:HD11	2.02	0.41
3:C:121:ASN:N	3:C:121:ASN:HD22	2.17	0.41
3:C:102:ILE:HD11	3:C:114:ILE:CG2	2.50	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:4:LYS:HG2	2:B:89:ILE:HG12	2.03	0.41
1:A:15:PHE:O	1:A:19:ILE:HG12	2.21	0.41
3:C:174:GLU:O	3:C:201:LEU:HD22	2.21	0.41
3:C:203:PHE:CZ	3:C:206:GLU:HG3	2.56	0.41
1:A:8:ASN:ND2	1:A:10:LYS:HB3	2.31	0.40
1:A:177:TYR:HA	2:B:108:SER:O	2.22	0.40
2:B:217:TYR:HB2	2:B:225:LYS:HB3	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	A	216/249 (87%)	209 (97%)	7 (3%)	0	100	100
2	B	243/245 (99%)	234 (96%)	9 (4%)	0	100	100
3	C	235/259 (91%)	230 (98%)	5 (2%)	0	100	100
All	All	694/753 (92%)	673 (97%)	21 (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	195/220 (89%)	187 (96%)	8 (4%)	30	39
2	B	215/219 (98%)	205 (95%)	10 (5%)	26	33
3	C	218/235 (93%)	208 (95%)	10 (5%)	27	34
All	All	628/674 (93%)	600 (96%)	28 (4%)	27	34

All (28) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	62	ILE
1	A	65	PRO
1	A	91	LEU
1	A	155	GLU
1	A	157	MET
1	A	166	ILE
1	A	194	THR
1	A	248	ARG
2	B	23	SER
2	B	51	LEU
2	B	64	GLU
2	B	72	LEU
2	B	87	THR
2	B	94	GLU
2	B	102	ASP
2	B	117	GLU
2	B	124	VAL
2	B	227	ARG
3	C	10	ASN
3	C	11	ILE
3	C	15	ASN
3	C	55	ASP
3	C	78	ASP
3	C	127	ARG
3	C	141	LEU
3	C	151	SER
3	C	199	GLN
3	C	212	SER

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	8	ASN

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Mol	Chain	Res	Type
1	A	17	ASN
1	A	21	ASN
1	A	39	HIS
1	A	135	ASN
2	B	125	ASN
2	B	160	ASN
2	B	203	ASN
3	C	10	ASN
3	C	15	ASN
3	C	31	GLN
3	C	121	ASN

### 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	226/249 (90%)	1.08	37 (16%) <b>1</b> <b>1</b>	46, 55, 63, 69	0
2	B	245/245 (100%)	0.75	5 (2%) 65 63	44, 54, 62, 66	1 (0%)
3	C	241/259 (93%)	0.87	8 (3%) 46 44	44, 54, 65, 69	0
All	All	712/753 (94%)	0.89	50 (7%) <b>16</b> <b>15</b>	44, 54, 64, 69	1 (0%)

All (50) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	83	SER	5.4
1	A	13	PHE	5.1
1	A	88	THR	4.6
1	A	79	LEU	4.5
1	A	20	THR	4.0
1	A	192	ILE	4.0
2	B	57	GLU	3.9
1	A	100	ILE	3.6
1	A	72	VAL	3.4
1	A	22	VAL	3.3
3	C	197	GLY	3.0
1	A	213	ARG	3.0
1	A	44	LYS	2.9
1	A	7	PRO	2.9
1	A	98	LEU	2.9
1	A	36	PHE	2.8
1	A	89	ILE	2.8
3	C	206	GLU	2.7
1	A	4	ILE	2.7
3	C	78	ASP	2.7
1	A	21	ASN	2.6
3	C	181	ALA	2.6
2	B	9	VAL	2.6

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Mol	Chain	Res	Type	RSRZ
1	A	25	SER	2.5
1	A	107	SER	2.5
1	A	2	PHE	2.5
3	C	165	THR	2.5
1	A	233	VAL	2.4
1	A	176	ARG	2.4
3	C	175	ASP	2.4
1	A	10	LYS	2.4
1	A	224	GLY	2.4
1	A	131	ASN	2.3
1	A	236	VAL	2.3
1	A	16	ILE	2.3
1	A	138	THR	2.2
2	B	1	MET	2.2
1	A	19	ILE	2.2
3	C	114	ILE	2.2
2	B	201	VAL	2.2
1	A	183	LYS	2.2
1	A	66	THR	2.2
1	A	158	ARG	2.2
1	A	196	ALA	2.1
1	A	242	ILE	2.1
2	B	155	ILE	2.1
3	C	120	THR	2.1
1	A	17	ASN	2.1
1	A	110	LYS	2.0
1	A	39	HIS	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.