



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 01:34 AM UTC

PDB ID : 8GNN / pdb_00008gnn
Title : Crystal structure of the human RAD9-RAD1-HUS1-RAD17 complex
Authors : Hara, K.; Nagata, K.; Iida, N.; Hashimoto, H.
Deposited on : 2022-08-24
Resolution : 2.12 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
Xtriage (Phenix)	:	2.0
EDS	:	3.0
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

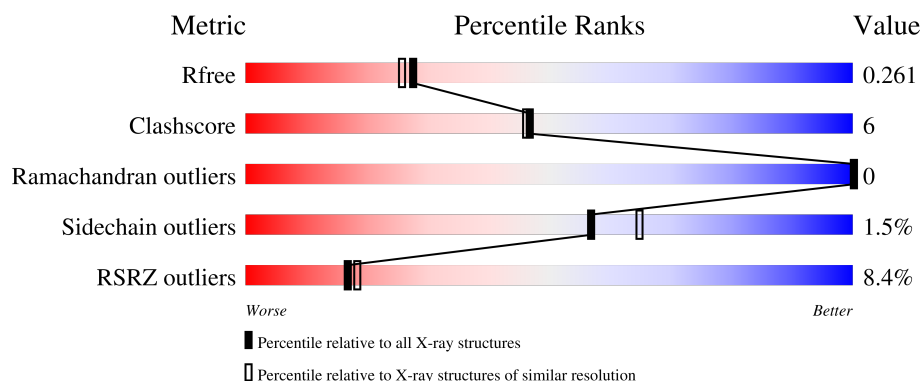
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.12 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	8290 (2.14-2.10)
Clashscore	190562	8817 (2.14-2.10)
Ramachandran outliers	187476	8738 (2.14-2.10)
Sidechain outliers	187428	8739 (2.14-2.10)
RSRZ outliers	180081	8294 (2.14-2.10)

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 ≥ 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	270	5% 81% 15% ..
2	B	286	7% 78% 16% 6%
3	C	282	11% 80% 11% 8%
4	D	11	18% 82% 9% 9%

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 6546 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 Cell cycle checkpoint control protein RAD9A.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	260	Total	C	N	O	S	0	0	0
			2009	1281	348	364	16			

- Molecule 2 is a protein called Checkpoint protein HUS1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	269	Total	C	N	O	S	0	0	0
			2158	1376	375	393	14			

There are 7 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-5	MET	-	initiating methionine	UNP O60921
B	-4	HIS	-	expression tag	UNP O60921
B	-3	HIS	-	expression tag	UNP O60921
B	-2	HIS	-	expression tag	UNP O60921
B	-1	HIS	-	expression tag	UNP O60921
B	0	HIS	-	expression tag	UNP O60921
B	1	HIS	-	expression tag	UNP O60921

- Molecule 3 is a protein called Cell cycle checkpoint protein RAD1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	259	Total	C	N	O	S	0	0	0
			2043	1296	337	393	17			

- Molecule 4 is a protein called Cell cycle checkpoint protein RAD17.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
4	D	10	Total	C	N	O	0	0	0
			84	53	11	20			

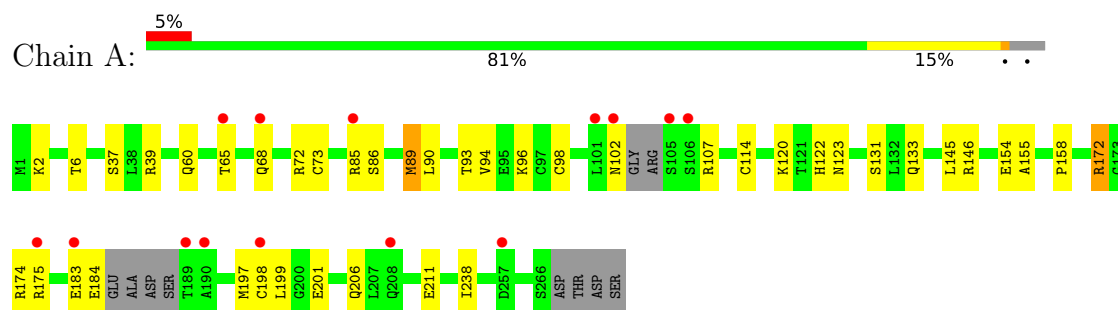
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	115	Total 115	O 115	0	0
5	B	71	Total 71	O 71	0	0
5	C	64	Total 64	O 64	0	0
5	D	2	Total 2	O 2	0	0

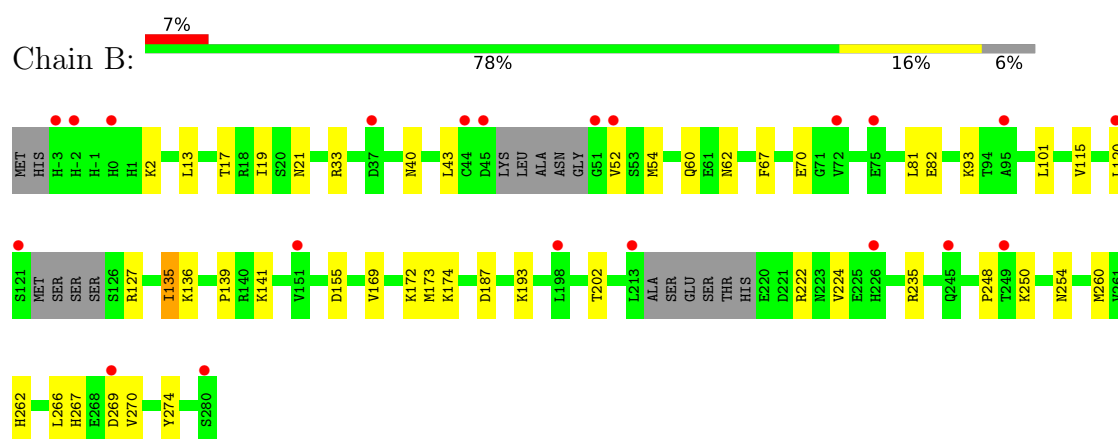
3 Residue-property plots [i](#)

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.

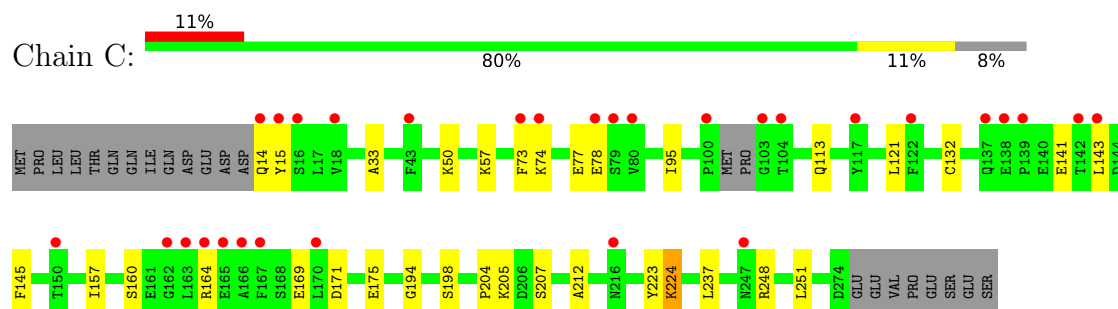
- Molecule 1: Cell cycle checkpoint control protein RAD9A



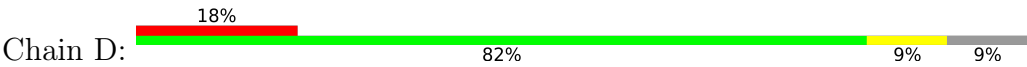
- Molecule 2: Checkpoint protein HUS1



- Molecule 3: Cell cycle checkpoint protein RAD1



- Molecule 4: Cell cycle checkpoint protein RAD17



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	53.19Å 136.30Å 154.05Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.81 – 2.12 19.81 – 2.12	Depositor EDS
% Data completeness (in resolution range)	99.8 (19.81-2.12) 94.7 (19.81-2.12)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	0.59 (at 2.11Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.217 , 0.263 0.221 , 0.261	Depositor DCC
R_{free} test set	2000 reflections (3.11%)	wwPDB-VP
Wilson B-factor (Å ²)	38.2	Xtriage
Anisotropy	0.349	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 40.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	6546	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 4.07% 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 [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	0.30	0/2044	0.72	1/2755 (0.0%)
2	B	0.25	0/2198	0.69	0/2973
3	C	0.28	0/2079	0.67	0/2810
4	D	0.45	0/87	0.77	0/120
All	All	0.28	0/6408	0.69	1/8658 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	73	CYS	N-CA-C	6.14	118.28	109.14

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	2009	0	2048	31	0
2	B	2158	0	2201	28	0
3	C	2043	0	2021	25	0
4	D	84	0	62	1	0
5	A	115	0	0	1	0
5	B	71	0	0	1	0
5	C	64	0	0	1	0
5	D	2	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	6546	0	6332	72	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 (72) 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:A:85:ARG:NH2	3:C:169:GLU:HG2	1.63	1.13
1:A:85:ARG:HH22	3:C:169:GLU:HG2	0.98	1.08
1:A:85:ARG:HH12	3:C:169:GLU:CG	1.84	0.91
1:A:85:ARG:HH22	3:C:169:GLU:CG	1.84	0.90
1:A:85:ARG:CZ	3:C:169:GLU:HG2	2.16	0.76
2:B:43:LEU:HB2	2:B:54:MET:HB3	1.73	0.71
3:C:73:PHE:C	3:C:74:LYS:HD3	2.18	0.69
1:A:72:ARG:HD2	1:A:131:SER:HB2	1.75	0.68
1:A:85:ARG:NH1	3:C:169:GLU:CG	2.56	0.67
2:B:2:LYS:HG2	2:B:70:GLU:HG2	1.77	0.66
1:A:172:ARG:HG3	1:A:211:GLU:OE2	1.95	0.65
2:B:81:LEU:HD22	2:B:135:ILE:HD13	1.78	0.64
1:A:6:THR:HG22	1:A:96:LYS:HG2	1.80	0.63
1:A:174:ARG:NH1	1:A:201:GLU:OE1	2.32	0.63
2:B:60:GLN:NE2	5:B:302:HOH:O	2.33	0.62
2:B:33:ARG:HB3	2:B:40:ASN:HB2	1.81	0.62
1:A:85:ARG:HH12	3:C:169:GLU:HG3	1.63	0.60
2:B:169:VAL:HG12	2:B:173:MET:HE2	1.83	0.60
1:A:85:ARG:NH1	3:C:169:GLU:HG2	2.17	0.59
1:A:93:THR:HG22	1:A:114:CYS:HB3	1.85	0.59
3:C:57:LYS:HA	3:C:143:LEU:HD11	1.86	0.58
1:A:154:GLU:OE1	2:B:127:ARG:NH1	2.31	0.57
2:B:60:GLN:HG3	2:B:67:PHE:CG	2.39	0.57
3:C:205:LYS:NZ	5:C:305:HOH:O	2.37	0.57
1:A:85:ARG:HH12	3:C:169:GLU:CD	2.14	0.56
2:B:101:LEU:HD11	2:B:115:VAL:HG13	1.88	0.56
2:B:60:GLN:HG3	2:B:67:PHE:CD2	2.41	0.56
1:A:102:ASN:HD21	1:A:107:ARG:H	1.54	0.55
3:C:121:LEU:HB2	3:C:132:CYS:HB2	1.90	0.54
1:A:2:LYS:NZ	1:A:98:CYS:SG	2.81	0.54
2:B:250:LYS:HB3	2:B:266:LEU:HB3	1.90	0.53
1:A:86:SER:HB3	1:A:89:MET:HE3	1.90	0.53
3:C:15:TYR:HD1	3:C:113:GLN:HA	1.76	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:60:GLN:OE1	5:A:301:HOH:O	2.20	0.50
2:B:254:ASN:HB2	2:B:262:HIS:HB3	1.93	0.50
1:A:65:THR:HB	1:A:68:GLN:HB3	1.94	0.50
1:A:123:ASN:HB2	3:C:198:SER:HB3	1.92	0.49
1:A:146:ARG:NH1	1:A:206:GLN:OE1	2.37	0.49
1:A:155:ALA:HB2	1:A:199:LEU:HD11	1.95	0.49
2:B:139:PRO:HB2	2:B:141:LYS:HE3	1.95	0.48
1:A:37:SER:OG	1:A:39:ARG:NH1	2.48	0.47
3:C:157:ILE:HB	3:C:212:ALA:HB3	1.97	0.47
2:B:52:VAL:HG11	2:B:274:TYR:CZ	2.49	0.47
2:B:82:GLU:HB3	2:B:136:LYS:HB3	1.95	0.47
2:B:174:LYS:HE2	2:B:235:ARG:HG2	1.96	0.47
1:A:102:ASN:ND2	1:A:107:ARG:H	2.13	0.47
1:A:145:LEU:HD11	1:A:238:ILE:HD12	1.97	0.47
3:C:204:PRO:HG2	3:C:207:SER:HB2	1.98	0.46
1:A:39:ARG:CZ	1:A:133:GLN:HG2	2.46	0.46
1:A:120:LYS:HE3	1:A:122:HIS:CE1	2.51	0.46
2:B:172:LYS:HB3	3:C:95:ILE:HD12	1.98	0.45
3:C:33:ALA:HB2	3:C:237:LEU:HD12	1.98	0.45
2:B:155:ASP:HB3	2:B:222:ARG:NH1	2.32	0.45
3:C:145:PHE:O	3:C:248:ARG:NH2	2.40	0.45
2:B:62:ASN:HB3	2:B:269:ASP:OD2	2.17	0.45
2:B:43:LEU:HD13	2:B:54:MET:HE2	1.99	0.44
1:A:158:PRO:HG2	1:A:197:MET:HE2	1.99	0.43
2:B:120:LEU:HD12	2:B:120:LEU:HA	1.84	0.43
3:C:223:TYR:CZ	3:C:251:LEU:HB2	2.53	0.43
3:C:171:ASP:OD2	3:C:194:GLY:HA3	2.20	0.42
1:A:90:LEU:HD23	1:A:94:VAL:HG21	2.00	0.42
2:B:19:ILE:HD11	2:B:270:VAL:HG21	2.02	0.42
2:B:193:LYS:HG2	2:B:202:THR:HG23	2.01	0.42
2:B:17:THR:O	2:B:21:ASN:ND2	2.43	0.41
3:C:50:LYS:HD3	4:D:16:THR:OG1	2.19	0.41
2:B:187:ASP:HB2	2:B:224:VAL:HG12	2.03	0.41
2:B:260:MET:HE2	2:B:260:MET:HB3	1.89	0.41
3:C:160:SER:O	3:C:164:ARG:HG3	2.20	0.41
2:B:13:LEU:HD12	2:B:13:LEU:HA	1.81	0.41
1:A:175:ARG:HD2	1:A:198:CYS:SG	2.60	0.40
2:B:248:PRO:HA	2:B:267:HIS:ND1	2.36	0.40
3:C:175:GLU:HG3	3:C:224:LYS:HE3	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	254/270 (94%)	252 (99%)	2 (1%)	0	100	100
2	B	261/286 (91%)	252 (97%)	9 (3%)	0	100	100
3	C	255/282 (90%)	247 (97%)	8 (3%)	0	100	100
4	D	8/11 (73%)	7 (88%)	1 (12%)	0	100	100
All	All	778/849 (92%)	758 (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	221/229 (96%)	217 (98%)	4 (2%)	51	59
2	B	249/263 (95%)	247 (99%)	2 (1%)	73	80
3	C	233/256 (91%)	228 (98%)	5 (2%)	47	54
4	D	10/11 (91%)	10 (100%)	0	100	100
All	All	713/759 (94%)	702 (98%)	11 (2%)	57	65

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	89	MET
1	A	172	ARG

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Mol	Chain	Res	Type
1	A	183	GLU
1	A	184	GLU
2	B	93	LYS
2	B	135	ILE
3	C	14	GLN
3	C	77	GLU
3	C	78	GLU
3	C	141	GLU
3	C	224	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	123	ASN
1	A	239	HIS
2	B	-2	HIS
2	B	0	HIS
2	B	60	GLN
2	B	76	ASN
3	C	62	ASN
3	C	151	ASN
3	C	178	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](#)

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, 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	260/270 (96%)	0.27	14 (5%) 31 34	24, 40, 68, 97	0
2	B	269/286 (94%)	0.73	21 (7%) 19 21	33, 49, 74, 102	0
3	C	259/282 (91%)	0.79	30 (11%) 9 10	35, 50, 77, 95	0
4	D	10/11 (90%)	1.45	2 (20%) 3 3	46, 49, 69, 92	0
All	All	798/849 (93%)	0.61	67 (8%) 17 18	24, 46, 74, 102	0

All (67) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	249	THR	5.0
2	B	120	LEU	4.9
3	C	167	PHE	4.6
2	B	213	LEU	4.5
2	B	95	ALA	4.2
1	A	102	ASN	4.2
2	B	121	SER	4.1
2	B	245	GLN	4.1
3	C	139	PRO	4.1
2	B	44	CYS	4.0
4	D	25	ASP	3.9
3	C	43	PHE	3.8
1	A	190	ALA	3.8
2	B	-2	HIS	3.8
2	B	72	VAL	3.8
3	C	142	THR	3.7
3	C	100	PRO	3.6
3	C	103	GLY	3.6
3	C	216	ASN	3.6
4	D	16	THR	3.5
3	C	117	TYR	3.4

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Mol	Chain	Res	Type	RSRZ
3	C	162	GLY	3.3
1	A	85	ARG	3.2
3	C	15	TYR	3.2
3	C	104	THR	3.2
2	B	-3	HIS	3.2
2	B	51	GLY	3.2
3	C	170	LEU	3.1
1	A	68	GLN	3.1
3	C	165	GLU	3.1
2	B	269	ASP	3.0
3	C	163	LEU	3.0
3	C	138	GLU	3.0
3	C	166	ALA	2.9
2	B	280	SER	2.9
2	B	75	GLU	2.8
3	C	80	VAL	2.8
1	A	189	THR	2.8
3	C	73	PHE	2.6
2	B	52	VAL	2.6
3	C	16	SER	2.6
3	C	78	GLU	2.6
2	B	0	HIS	2.6
1	A	106	SER	2.6
3	C	143	LEU	2.6
1	A	183	GLU	2.5
2	B	151	VAL	2.5
2	B	45	ASP	2.5
2	B	226	HIS	2.5
2	B	37	ASP	2.4
2	B	198	LEU	2.3
1	A	105	SER	2.3
1	A	65	THR	2.3
1	A	175	ARG	2.3
3	C	164	ARG	2.2
3	C	247	ASN	2.2
3	C	137	GLN	2.2
3	C	74	LYS	2.2
3	C	150	THR	2.2
1	A	101	LEU	2.1
3	C	79	SER	2.1
1	A	257	ASP	2.1
1	A	198	CYS	2.1

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Mol	Chain	Res	Type	RSRZ
3	C	122	PHE	2.1
1	A	208	GLN	2.1
3	C	18	VAL	2.0
3	C	14	GLN	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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.