



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 12:33 AM UTC

PDB ID : 1KL4 / pdb_00001kl4
Title : AN ENGINEERED STREPTAVIDIN WITH IMPROVED AFFINITY FOR
THE STREP-TAG II PEPTIDE : apo-SAM2
Authors : Korndorfer, I.P.; Skerra, A.
Deposited on : 2001-12-11
Resolution : 1.70 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

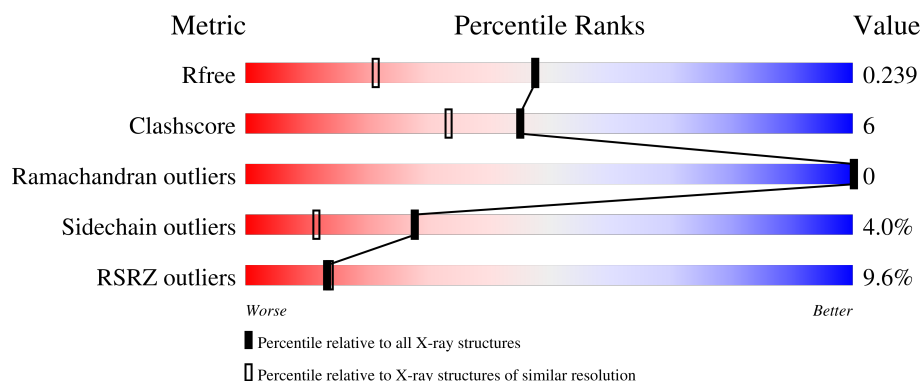
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.70 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	5551 (1.70-1.70)
Clashscore	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)
RSRZ outliers	180081	5554 (1.70-1.70)

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	127	7% 76% 17% • 6%
1	B	127	7% 74% 20% • 6%
1	C	127	9% 77% 15% • 6%
1	D	127	13% 76% 15% • 6%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 3775 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 streptavidin.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
1	A	120	Total	C	N	O	0	0	0
			899	563	159	177			
1	B	120	Total	C	N	O	0	0	0
			897	561	159	177			
1	C	119	Total	C	N	O	0	0	0
			892	558	158	176			
1	D	119	Total	C	N	O	0	0	0
			892	558	158	176			

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	13	MET	-	initiating methionine	UNP P22629
A	44	ILE	GLU	engineered mutation	UNP P22629
A	45	GLY	SER	engineered mutation	UNP P22629
A	47	ARG	VAL	engineered mutation	UNP P22629
B	13	MET	-	initiating methionine	UNP P22629
B	44	ILE	GLU	engineered mutation	UNP P22629
B	45	GLY	SER	engineered mutation	UNP P22629
B	47	ARG	VAL	engineered mutation	UNP P22629
C	13	MET	-	initiating methionine	UNP P22629
C	44	ILE	GLU	engineered mutation	UNP P22629
C	45	GLY	SER	engineered mutation	UNP P22629
C	47	ARG	VAL	engineered mutation	UNP P22629
D	13	MET	-	initiating methionine	UNP P22629
D	44	ILE	GLU	engineered mutation	UNP P22629
D	45	GLY	SER	engineered mutation	UNP P22629
D	47	ARG	VAL	engineered mutation	UNP P22629

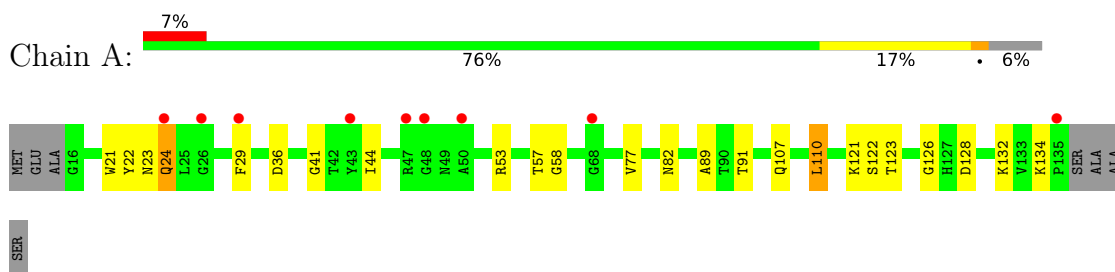
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	51	Total 51	O 51	0	0
2	B	51	Total 51	O 51	0	0
2	C	59	Total 59	O 59	0	0
2	D	34	Total 34	O 34	0	0

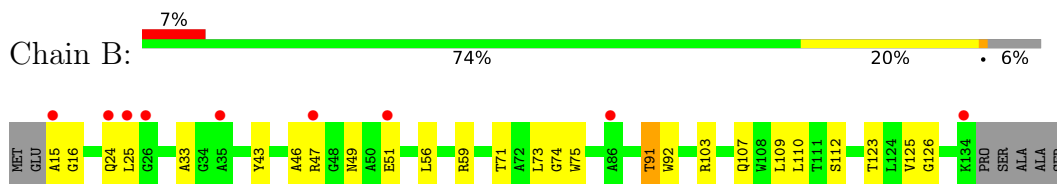
3 Residue-property plots [i](#)

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.

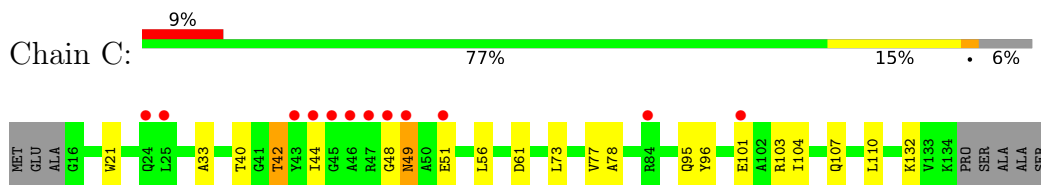
- Molecule 1: streptavidin



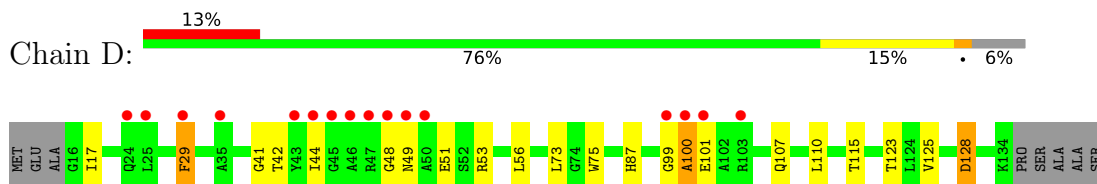
- Molecule 1: streptavidin



- Molecule 1: streptavidin



- Molecule 1: streptavidin



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	58.45Å 86.81Å 47.08Å 90.00° 98.82° 90.00°	Depositor
Resolution (Å)	20.52 – 1.70 20.52 – 1.70	Depositor EDS
% Data completeness (in resolution range)	93.8 (20.52-1.70) 93.8 (20.52-1.70)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.01	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.03 (at 1.69Å)	Xtriage
Refinement program	CNS, REFMAC	Depositor
R, R_{free}	0.191 , 0.228 0.203 , 0.239	Depositor DCC
R_{free} test set	2387 reflections (4.93%)	wwPDB-VP
Wilson B-factor (Å ²)	22.8	Xtriage
Anisotropy	0.266	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.40 , 49.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	3775	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.15% 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	1.10	0/922	1.61	12/1261 (1.0%)
1	B	1.18	4/919 (0.4%)	1.68	19/1256 (1.5%)
1	C	1.09	2/914 (0.2%)	1.57	15/1249 (1.2%)
1	D	1.08	1/914 (0.1%)	1.54	11/1249 (0.9%)
All	All	1.11	7/3669 (0.2%)	1.60	57/5015 (1.1%)

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	33	ALA	CA-CB	-6.57	1.44	1.53
1	B	125	VAL	C-O	-6.48	1.17	1.24
1	C	104	ILE	CA-CB	-6.00	1.46	1.54
1	B	71	THR	C-O	-5.70	1.17	1.24
1	D	125	VAL	CA-CB	5.25	1.62	1.54
1	B	74	GLY	N-CA	-5.22	1.40	1.45
1	B	107	GLN	CA-C	5.09	1.58	1.52

All (57) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	42	THR	OG1-CB-CG2	-10.21	88.88	109.30
1	A	89	ALA	CA-C-O	8.05	130.44	120.54
1	B	16	GLY	N-CA-C	-7.99	104.98	114.48
1	C	77	VAL	CA-C-O	-7.82	112.18	120.39
1	D	99	GLY	N-CA-C	-6.92	103.03	112.52
1	D	100	ALA	N-CA-C	-6.76	98.60	109.96
1	B	126	GLY	CA-C-O	6.70	127.68	121.38
1	A	134	LYS	N-CA-C	6.63	118.01	109.65
1	B	33	ALA	CA-C-N	6.55	127.21	120.60
1	B	33	ALA	C-N-CA	6.55	127.21	120.60
1	C	48	GLY	CA-C-N	6.46	131.08	120.94
1	C	48	GLY	C-N-CA	6.46	131.08	120.94
1	B	92	TRP	CA-CB-CG	6.30	125.56	113.60

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	46	ALA	N-CA-C	6.30	118.95	111.33
1	C	95	GLN	CA-CB-CG	6.18	126.46	114.10
1	B	74	GLY	O-C-N	6.11	129.24	123.56
1	C	49	ASN	N-CA-CB	-6.06	101.44	110.17
1	B	91	THR	N-CA-CB	6.00	120.76	110.68
1	A	58	GLY	CA-C-O	-5.98	115.76	121.38
1	C	78	ALA	N-CA-C	-5.95	100.01	109.76
1	D	75	TRP	N-CA-C	5.93	118.09	109.07
1	D	41	GLY	N-CA-C	5.89	118.81	110.74
1	D	29	PHE	CA-CB-CG	5.85	119.65	113.80
1	C	104	ILE	CA-C-O	-5.83	114.33	120.39
1	D	17	ILE	N-CA-C	5.81	116.55	110.62
1	D	123	THR	N-CA-C	5.76	117.81	108.41
1	A	29	PHE	N-CA-C	-5.75	97.80	108.02
1	D	107	GLN	CA-CB-CG	-5.72	102.65	114.10
1	A	41	GLY	N-CA-C	5.68	117.84	110.45
1	C	44	ILE	N-CA-C	5.68	116.04	107.75
1	D	107	GLN	N-CA-C	-5.57	100.81	109.72
1	C	107	GLN	N-CA-C	-5.56	100.83	109.72
1	B	109	LEU	CA-C-O	-5.49	114.34	120.66
1	B	16	GLY	CA-C-O	5.49	124.86	119.37
1	A	123	THR	N-CA-C	5.43	117.60	107.99
1	A	22	TYR	CA-C-O	5.42	126.89	120.66
1	D	115	THR	N-CA-C	-5.41	103.55	110.53
1	B	75	TRP	N-CA-C	5.40	117.06	108.79
1	C	96	TYR	CA-C-N	-5.38	116.10	123.14
1	C	96	TYR	C-N-CA	-5.38	116.10	123.14
1	A	128	ASP	CB-CG-OD2	5.36	130.74	118.40
1	D	128	ASP	CA-CB-CG	5.36	117.96	112.60
1	A	126	GLY	CA-C-O	5.34	126.40	121.38
1	B	107	GLN	N-CA-C	-5.27	101.28	109.72
1	B	112	SER	CA-C-N	-5.24	114.88	120.43
1	B	112	SER	C-N-CA	-5.24	114.88	120.43
1	B	123	THR	N-CA-C	5.24	116.94	108.34
1	A	58	GLY	N-CA-C	5.22	119.99	111.27
1	B	107	GLN	CA-C-O	-5.20	115.23	121.11
1	C	104	ILE	O-C-N	5.17	128.69	123.20
1	A	122	SER	N-CA-C	5.16	117.80	111.82
1	A	77	VAL	CB-CA-C	-5.15	103.11	110.12
1	C	107	GLN	CA-CB-CG	-5.13	103.85	114.10
1	B	107	GLN	CA-CB-CG	-5.11	103.89	114.10
1	C	40	THR	OG1-CB-CG2	-5.11	99.09	109.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	91	THR	O-C-N	5.07	129.34	123.30
1	B	92	TRP	O-C-N	-5.06	117.32	123.29

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	899	0	850	12	1
1	B	897	0	848	12	1
1	C	892	0	843	11	0
1	D	892	0	843	10	0
2	A	51	0	0	0	0
2	B	51	0	0	4	0
2	C	59	0	0	0	0
2	D	34	0	0	0	0
All	All	3775	0	3384	41	1

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 (41) 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:49:ASN:ND2	1:B:51:GLU:OE1	1.87	1.05
1:C:101:GLU:HA	1:C:101:GLU:OE1	1.57	1.03
1:A:24:GLN:NE2	1:A:24:GLN:H	1.63	0.96
1:B:15:ALA:HA	2:B:179:HOH:O	1.77	0.82
1:B:43:TYR:OH	2:B:185:HOH:O	2.01	0.77
1:C:49:ASN:ND2	1:C:51:GLU:HG3	2.01	0.75
1:C:61:ASP:OD2	1:D:87:HIS:HD2	1.71	0.73
1:A:24:GLN:NE2	1:A:24:GLN:N	2.37	0.70
1:A:23:ASN:HB2	1:A:24:GLN:NE2	2.09	0.68
1:A:23:ASN:HB2	1:A:24:GLN:HE22	1.59	0.68

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:49:ASN:ND2	1:D:51:GLU:OE1	2.27	0.67
1:C:49:ASN:ND2	1:C:51:GLU:CG	2.60	0.64
1:A:24:GLN:N	1:A:24:GLN:HE21	1.95	0.63
1:B:51:GLU:H	1:B:51:GLU:CD	2.10	0.60
1:B:15:ALA:N	2:B:159:HOH:O	2.35	0.58
1:A:21:TRP:CZ2	1:A:132:LYS:HE3	2.40	0.56
1:A:24:GLN:H	1:A:24:GLN:CD	2.15	0.55
1:D:100:ALA:O	1:D:101:GLU:HB2	2.12	0.50
1:C:21:TRP:CZ2	1:C:132:LYS:HE3	2.47	0.49
1:C:49:ASN:HD22	1:C:51:GLU:HB2	1.76	0.49
1:C:110:LEU:C	1:C:110:LEU:HD23	2.37	0.49
1:C:73:LEU:HD12	1:C:73:LEU:C	2.37	0.49
1:C:103:ARG:HH11	1:C:103:ARG:HG3	1.78	0.49
1:D:100:ALA:O	1:D:101:GLU:CB	2.62	0.48
1:A:110:LEU:C	1:A:110:LEU:HD23	2.39	0.48
1:A:91:THR:HB	1:B:91:THR:HB	1.97	0.47
1:D:51:GLU:H	1:D:51:GLU:CD	2.22	0.47
1:D:29:PHE:CD1	1:D:56:LEU:HD22	2.50	0.46
1:D:110:LEU:C	1:D:110:LEU:HD23	2.40	0.46
1:A:36:ASP:N	1:A:36:ASP:OD1	2.46	0.46
1:C:61:ASP:OD2	1:D:87:HIS:CD2	2.59	0.46
1:C:101:GLU:O	1:C:103:ARG:NH1	2.47	0.46
1:B:51:GLU:CD	1:B:51:GLU:N	2.74	0.44
1:B:103:ARG:HD2	2:B:184:HOH:O	2.17	0.44
1:B:103:ARG:HE	1:B:103:ARG:HB3	1.44	0.44
1:B:49:ASN:CG	1:B:51:GLU:OE1	2.59	0.43
1:D:44:ILE:HG12	1:D:53:ARG:HG2	2.00	0.43
1:B:51:GLU:N	1:B:51:GLU:OE2	2.54	0.41
1:A:57:THR:HG22	1:B:59:ARG:HG2	2.02	0.40
1:D:44:ILE:HG22	1:D:48:GLY:HA2	2.02	0.40
1:A:44:ILE:CD1	1:A:53:ARG:NH1	2.84	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:82:ASN:O	1:B:47:ARG:NH1[1_556]	2.14	0.06

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	118/127 (93%)	116 (98%)	2 (2%)	0	100	100
1	B	118/127 (93%)	115 (98%)	3 (2%)	0	100	100
1	C	117/127 (92%)	114 (97%)	3 (3%)	0	100	100
1	D	117/127 (92%)	113 (97%)	4 (3%)	0	100	100
All	All	470/508 (92%)	458 (97%)	12 (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	88/92 (96%)	84 (96%)	4 (4%)	24	9
1	B	87/92 (95%)	82 (94%)	5 (6%)	18	6
1	C	87/92 (95%)	85 (98%)	2 (2%)	44	27
1	D	87/92 (95%)	84 (97%)	3 (3%)	32	16
All	All	349/368 (95%)	335 (96%)	14 (4%)	28	12

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	24	GLN
1	A	107	GLN

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Mol	Chain	Res	Type
1	A	110	LEU
1	A	121	LYS
1	B	24	GLN
1	B	25	LEU
1	B	56	LEU
1	B	73	LEU
1	B	110	LEU
1	C	42	THR
1	C	56	LEU
1	D	42	THR
1	D	73	LEU
1	D	128	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	24	GLN
1	A	82	ASN
1	A	105	ASN
1	B	82	ASN
1	B	107	GLN
1	C	24	GLN
1	C	49	ASN
1	C	127	HIS
1	D	87	HIS
1	D	127	HIS

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry

There are no ligands in this entry.

5.7 Other polymers

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, 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	120/127 (94%)	0.49	9 (7%) 20 22	13, 22, 42, 56	0
1	B	120/127 (94%)	0.49	9 (7%) 20 22	13, 21, 42, 49	0
1	C	119/127 (93%)	0.58	12 (10%) 12 13	14, 21, 44, 61	0
1	D	119/127 (93%)	0.71	16 (13%) 7 6	14, 25, 49, 63	0
All	All	478/508 (94%)	0.57	46 (9%) 13 14	13, 22, 44, 63	0

All (46) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	100	ALA	5.2
1	D	46	ALA	4.5
1	D	43	TYR	4.4
1	C	49	ASN	4.4
1	C	101	GLU	4.3
1	A	68	GLY	4.2
1	B	15	ALA	4.2
1	D	29	PHE	4.1
1	D	50	ALA	3.9
1	C	47	ARG	3.3
1	B	35	ALA	3.2
1	D	49	ASN	3.2
1	C	24	GLN	3.0
1	D	47	ARG	3.0
1	C	46	ALA	3.0
1	B	134	LYS	3.0
1	C	25	LEU	3.0
1	C	44	ILE	2.9
1	B	24	GLN	2.9
1	C	43	TYR	2.9
1	A	47	ARG	2.8

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Mol	Chain	Res	Type	RSRZ
1	D	101	GLU	2.7
1	A	24	GLN	2.6
1	B	25	LEU	2.6
1	D	35	ALA	2.6
1	D	48	GLY	2.6
1	A	29	PHE	2.6
1	D	45	GLY	2.5
1	B	47	ARG	2.5
1	D	44	ILE	2.5
1	C	84	ARG	2.5
1	D	25	LEU	2.3
1	D	103	ARG	2.3
1	B	26	GLY	2.3
1	C	51	GLU	2.3
1	D	99	GLY	2.2
1	D	24	GLN	2.2
1	C	48	GLY	2.2
1	B	86	ALA	2.1
1	C	45	GLY	2.1
1	B	51	GLU	2.1
1	A	135	PRO	2.1
1	A	43	TYR	2.1
1	A	48	GLY	2.0
1	A	50	ALA	2.0
1	A	26	GLY	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.