



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 02:01 AM UTC

PDB ID : 5HPL / pdb_00005hpl
Title : System-wide modulation of HECT E3 ligases with selective ubiquitin variant probes: Rsp5 and UbV R5.4
Authors : Wu, K.-P.; Kamadurai, H.B.; Schulman, B.A.
Deposited on : 2016-01-20
Resolution : 2.31 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

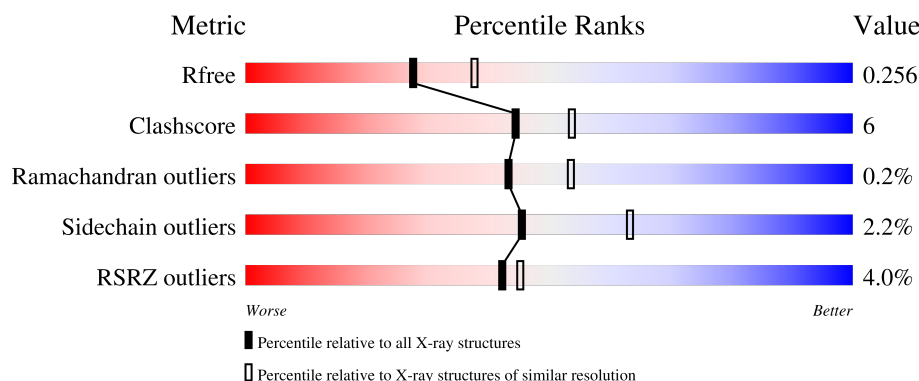
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.31 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	7754 (2.34-2.30)
Clashscore	190562	8383 (2.34-2.30)
Ramachandran outliers	187476	8303 (2.34-2.30)
Sidechain outliers	187428	8303 (2.34-2.30)
RSRZ outliers	180081	7760 (2.34-2.30)

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	380	0% 83% 14% • •
1	B	380	4% 83% 14% • •
2	C	86	5% 86% 7% • 6%
2	D	86	12% 79% 14% • 6%

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 7749 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 Rsp5.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	370	Total	C	N	O	S	0	0	0
			3078	1971	519	575	13			
1	B	370	Total	C	N	O	S	0	0	0
			3082	1973	522	574	13			

- Molecule 2 is a protein called Ubiquitin variant R5.4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	81	Total	C	N	O	S	0	0	0
			652	410	118	123	1			
2	D	81	Total	C	N	O	S	0	0	0
			652	410	118	123	1			

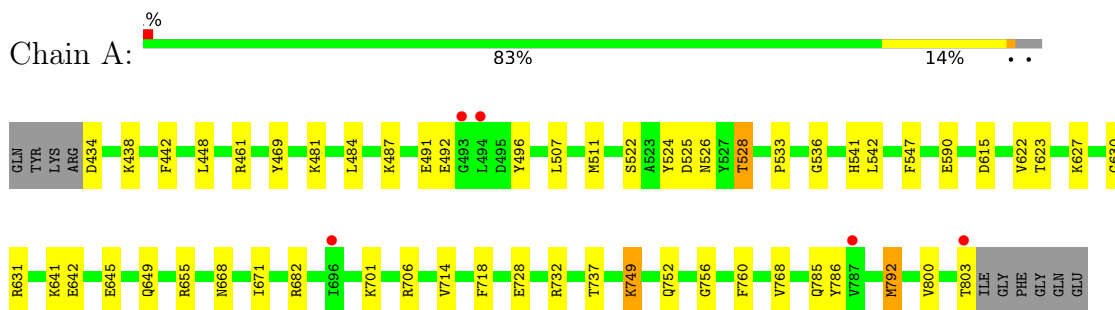
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	135	Total	O	0	0
			135	135		
3	B	119	Total	O	0	0
			119	119		
3	C	22	Total	O	0	0
			22	22		
3	D	9	Total	O	0	0
			9	9		

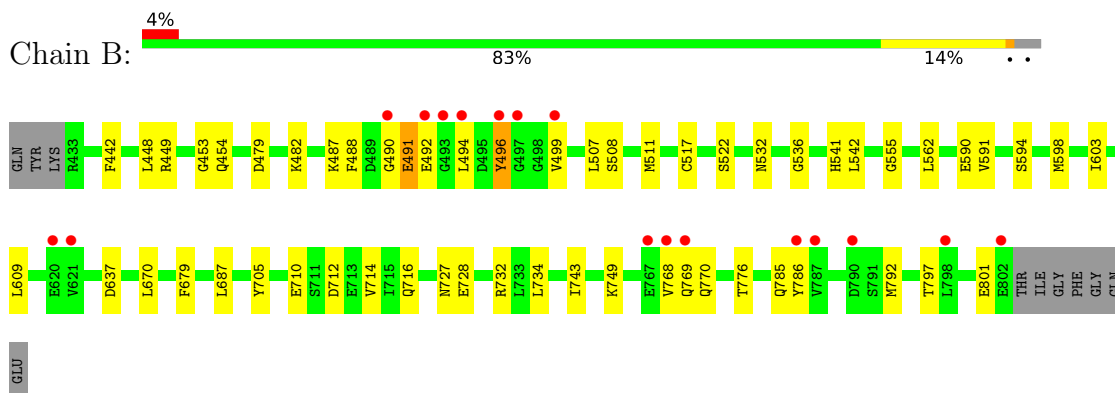
3 Residue-property plots [i](#)

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.

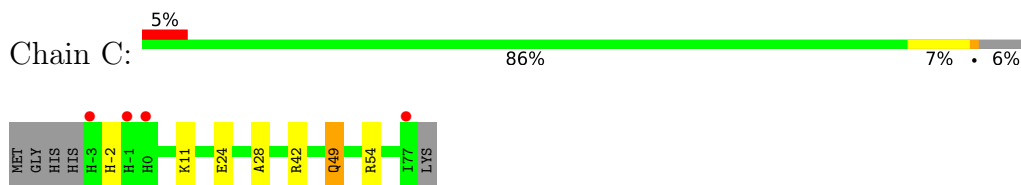
• Molecule 1: Rsp5



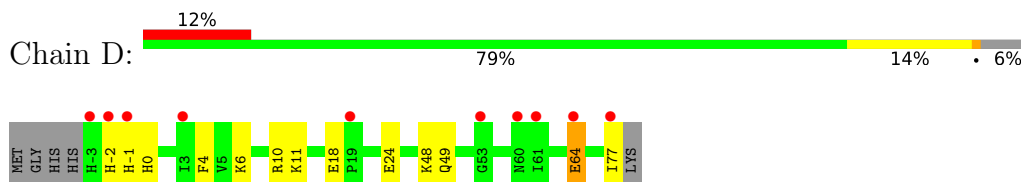
• Molecule 1: Rsp5



• Molecule 2: Ubiquitin variant R5.4



• Molecule 2: Ubiquitin variant R5.4



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	72.49Å 92.35Å 82.16Å 90.00° 101.60° 90.00°	Depositor
Resolution (Å)	80.48 – 2.31 80.48 – 2.31	Depositor EDS
% Data completeness (in resolution range)	98.2 (80.48-2.31) 98.2 (80.48-2.31)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.01 (at 2.32Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.191 , 0.254 0.199 , 0.256	Depositor DCC
R_{free} test set	2320 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å ²)	38.9	Xtriage
Anisotropy	0.430	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 30.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	7749	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.68% 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	0.57	0/3150	0.86	1/4250 (0.0%)
1	B	0.55	0/3154	0.84	1/4254 (0.0%)
2	C	0.56	0/664	0.90	1/896 (0.1%)
2	D	0.46	0/664	0.83	1/896 (0.1%)
All	All	0.55	0/7632	0.85	4/10296 (0.0%)

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	496	TYR	N-CA-C	6.10	118.71	111.33
1	A	630	GLY	N-CA-C	5.28	118.63	112.50
2	C	49	GLN	N-CA-C	-5.28	101.87	110.20
2	D	-1	HIS	N-CA-C	-5.13	107.19	112.93

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	3078	0	2984	35	2
1	B	3082	0	2990	45	0
2	C	652	0	668	7	2
2	D	652	0	668	6	0
3	A	135	0	0	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	119	0	0	0	0
3	C	22	0	0	1	0
3	D	9	0	0	0	0
All	All	7749	0	7310	88	2

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 (88) 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:C:42:ARG:HD3	2:C:49:GLN:NE2	1.92	0.85
1:A:522:SER:HB3	1:A:528:THR:HG22	1.60	0.82
1:B:769:GLN:HG3	1:B:770:GLN:HG3	1.66	0.77
1:A:728:GLU:OE2	1:A:732:ARG:NH1	2.19	0.76
1:B:496:TYR:HA	1:B:499:VAL:HG12	1.73	0.71
1:A:682:ARG:NH1	1:A:800:VAL:O	2.25	0.69
1:B:522:SER:O	2:D:10:ARG:NH2	2.26	0.67
1:A:706:ARG:NH2	1:B:705:TYR:O	2.28	0.67
1:B:768:VAL:HG13	1:B:786:TYR:HD1	1.61	0.66
1:B:728:GLU:CD	1:B:732:ARG:HH12	2.07	0.62
1:B:728:GLU:HG2	1:B:732:ARG:NH1	2.14	0.62
1:B:536:GLY:HA2	1:B:541:HIS:CE1	2.37	0.59
1:B:488:PHE:HB2	1:B:491:GLU:HG3	1.85	0.59
1:B:728:GLU:OE2	1:B:732:ARG:NH1	2.27	0.59
1:A:615:ASP:HB3	1:A:622:VAL:HG13	1.83	0.59
1:A:649:GLN:OE1	3:A:901:HOH:O	2.15	0.59
1:A:714:VAL:HG21	1:A:785:GLN:HG3	1.84	0.59
1:A:434:ASP:OD2	1:A:438:LYS:HE3	2.02	0.58
1:A:507:LEU:O	1:A:511:MET:HG3	2.05	0.57
1:A:623:THR:HG22	1:A:631:ARG:HH11	1.70	0.56
1:B:488:PHE:CE2	1:B:499:VAL:HG23	2.41	0.56
1:B:705:TYR:CE2	1:B:710:GLU:HG2	2.41	0.56
1:B:734:LEU:HD13	1:B:743:ILE:HD11	1.87	0.55
2:C:42:ARG:HH11	2:C:49:GLN:HE22	1.55	0.54
1:B:490:GLY:O	1:B:491:GLU:HB2	2.07	0.54
2:D:4:PHE:HE2	2:D:64:GLU:HG3	1.72	0.54
1:B:442:PHE:CE2	1:B:448:LEU:HD21	2.43	0.54
1:A:526:ASN:OD1	1:A:752:GLN:HG3	2.09	0.53
1:B:541:HIS:HD2	1:B:542:LEU:H	1.54	0.53
1:B:507:LEU:O	1:B:511:MET:HG3	2.07	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:541:HIS:CD2	1:B:542:LEU:HG	2.45	0.52
1:A:481:LYS:NZ	3:A:908:HOH:O	2.43	0.52
1:A:668:ASN:HA	1:A:671:ILE:O	2.10	0.52
1:A:749:LYS:HB3	3:A:961:HOH:O	2.10	0.51
2:D:48:LYS:NZ	2:D:49:GLN:O	2.39	0.51
1:A:442:PHE:CE2	1:A:448:LEU:HD21	2.45	0.51
1:A:627:LYS:NZ	1:A:642:GLU:OE2	2.41	0.51
1:B:541:HIS:CD2	1:B:542:LEU:N	2.79	0.50
1:B:555:GLY:HA3	1:B:562:LEU:HD11	1.93	0.50
2:C:42:ARG:NH1	2:C:49:GLN:HE22	2.08	0.50
1:B:536:GLY:HA2	1:B:541:HIS:ND1	2.27	0.50
1:A:442:PHE:O	1:A:448:LEU:HD22	2.12	0.49
1:B:786:TYR:CD2	1:B:792:MET:HG3	2.48	0.49
1:B:786:TYR:HD2	1:B:792:MET:HG3	1.79	0.48
2:D:0:HIS:HA	2:D:18:GLU:OE2	2.13	0.47
1:B:453:GLY:C	1:B:454:GLN:HG3	2.39	0.47
1:B:714:VAL:HG21	1:B:785:GLN:HG3	1.96	0.47
1:B:728:GLU:CG	1:B:732:ARG:HH12	2.27	0.46
1:B:541:HIS:CD2	1:B:542:LEU:H	2.34	0.46
2:C:11:LYS:NZ	3:C:101:HOH:O	2.39	0.46
2:C:42:ARG:HH11	2:C:49:GLN:NE2	2.14	0.46
1:A:737:THR:HG21	1:A:760:PHE:CE1	2.51	0.45
1:B:797:THR:O	1:B:801:GLU:HG3	2.15	0.45
1:A:768:VAL:HG13	1:A:786:TYR:HD1	1.82	0.45
1:B:679:PHE:CE2	1:B:687:LEU:HD22	2.51	0.45
1:A:623:THR:HG22	1:A:631:ARG:NH1	2.32	0.45
1:A:541:HIS:CD2	1:A:542:LEU:N	2.84	0.45
1:A:682:ARG:HH21	1:A:803:THR:CG2	2.30	0.44
1:A:623:THR:CG2	1:A:631:ARG:HH11	2.30	0.44
1:B:492:GLU:HG2	2:C:28:ALA:HB1	1.99	0.44
1:B:768:VAL:HG13	1:B:786:TYR:CD1	2.48	0.44
1:B:594:SER:O	1:B:598:MET:HG3	2.18	0.44
1:A:536:GLY:HA2	1:A:541:HIS:CE1	2.53	0.43
1:A:533:PRO:HB3	1:A:655:ARG:HG2	2.00	0.43
1:A:469:TYR:HA	1:A:547:PHE:CE1	2.53	0.43
1:A:641:LYS:O	1:A:645:GLU:HG3	2.17	0.43
1:B:734:LEU:HA	1:B:734:LEU:HD23	1.81	0.43
1:B:479:ASP:HA	1:B:482:LYS:HE2	2.00	0.42
1:A:461:ARG:HD3	3:A:948:HOH:O	2.19	0.42
1:A:756:GLY:HA3	1:B:749:LYS:HG3	2.02	0.42
1:B:496:TYR:HA	1:B:499:VAL:CG1	2.46	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:487:LYS:HE2	1:A:491:GLU:O	2.19	0.42
1:A:682:ARG:HH21	1:A:803:THR:HG23	1.85	0.41
1:A:718:PHE:HB2	1:A:792:MET:HE1	2.01	0.41
1:B:508:SER:HA	1:B:511:MET:HE2	2.02	0.41
1:A:484:LEU:HD12	1:A:484:LEU:HA	1.87	0.41
1:B:492:GLU:HG2	2:C:28:ALA:CB	2.50	0.41
2:D:48:LYS:HD2	2:D:49:GLN:N	2.35	0.41
1:B:536:GLY:CA	1:B:541:HIS:CE1	3.04	0.41
1:A:522:SER:CB	1:A:528:THR:HG22	2.42	0.41
1:A:525:ASP:OD2	1:A:528:THR:HB	2.20	0.41
1:B:517:CYS:O	1:B:532:ASN:HB3	2.21	0.41
1:B:603:ILE:HG12	1:B:637:ASP:OD1	2.21	0.41
2:D:6:LYS:HE3	2:D:6:LYS:HB2	1.83	0.41
1:B:442:PHE:O	1:B:448:LEU:HD22	2.21	0.40
1:B:712:ASP:O	1:B:716:GLN:HG2	2.21	0.40
1:B:598:MET:HE1	1:B:609:LEU:HD11	2.02	0.40
1:B:491:GLU:OE1	1:B:494:LEU:HD11	2.21	0.40

All (2) 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:492:GLU:OE2	2:C:54:ARG:NH1[2_757]	1.95	0.25
1:A:496:TYR:OH	2:C:24:GLU:OE1[2_757]	2.11	0.09

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	368/380 (97%)	365 (99%)	3 (1%)	0	100	100
1	B	368/380 (97%)	359 (98%)	8 (2%)	1 (0%)	36	45

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	C	79/86 (92%)	77 (98%)	2 (2%)	0	100	100
2	D	79/86 (92%)	75 (95%)	3 (4%)	1 (1%)	9	10
All	All	894/932 (96%)	876 (98%)	16 (2%)	2 (0%)	43	53

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	491	GLU
2	D	-2	HIS

5.3.2 Protein sidechains ⓘ

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	334/342 (98%)	328 (98%)	6 (2%)	51	69
1	B	334/342 (98%)	327 (98%)	7 (2%)	47	65
2	C	75/79 (95%)	74 (99%)	1 (1%)	61	76
2	D	75/79 (95%)	71 (95%)	4 (5%)	20	29
All	All	818/842 (97%)	800 (98%)	18 (2%)	45	63

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	524	TYR
1	A	528	THR
1	A	590	GLU
1	A	701	LYS
1	A	749	LYS
1	A	792	MET
1	B	449	ARG
1	B	487	LYS
1	B	590	GLU
1	B	591	VAL

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Mol	Chain	Res	Type
1	B	670	LEU
1	B	727	ASN
1	B	776	THR
2	C	-2	HIS
2	D	11	LYS
2	D	24	GLU
2	D	64	GLU
2	D	77	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	454	GLN
1	A	463	ASN
1	A	657	GLN
1	B	746	ASN
1	B	752	GLN
2	C	49	GLN
2	C	68	HIS
2	D	0	HIS

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	370/380 (97%)	-0.02	5 (1%) 73 75	27, 39, 56, 77	0
1	B	370/380 (97%)	0.33	17 (4%) 37 40	30, 43, 74, 93	0
2	C	81/86 (94%)	0.33	4 (4%) 35 37	33, 42, 60, 78	0
2	D	81/86 (94%)	0.86	10 (12%) 8 9	40, 58, 78, 86	0
All	All	902/932 (96%)	0.23	36 (3%) 42 45	27, 42, 71, 93	0

All (36) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	C	-3	HIS	4.7
1	B	493	GLY	4.7
2	C	-1	HIS	4.7
1	B	492	GLU	4.0
2	D	77	ILE	3.8
2	D	-3	HIS	3.6
1	B	496	TYR	3.4
2	D	60	ASN	3.2
1	B	499	VAL	3.1
1	B	494	LEU	3.0
2	C	77	ILE	3.0
1	B	787	VAL	3.0
1	B	490	GLY	2.9
1	B	768	VAL	2.9
1	A	494	LEU	2.8
1	A	803	THR	2.8
2	D	-1	HIS	2.8
1	A	493	GLY	2.8
1	B	769	GLN	2.7
1	B	767	GLU	2.6
1	B	802	GLU	2.5

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Mol	Chain	Res	Type	RSRZ
1	A	787	VAL	2.5
1	B	621	VAL	2.5
2	D	-2	HIS	2.4
2	D	3	ILE	2.4
1	B	497	GLY	2.3
2	D	61	ILE	2.3
2	C	0	HIS	2.3
1	B	790	ASP	2.2
2	D	53	GLY	2.1
1	A	696	ILE	2.1
1	B	798	LEU	2.1
2	D	19	PRO	2.1
2	D	64	GLU	2.1
1	B	786	TYR	2.0
1	B	620	GLU	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.