



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 08:33 PM UTC

PDB ID : 5NKZ / pdb_00005nkz
Title : Crystal structure of H. polymorpha ubiquitin conjugating enzyme Pex4p in complex with soluble domain of Pex22p
Authors : Danda, N.; Lunev, S.; Ali, A.; Groves, M.R.; Williams, C.
Deposited on : 2017-04-03
Resolution : 2.85 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

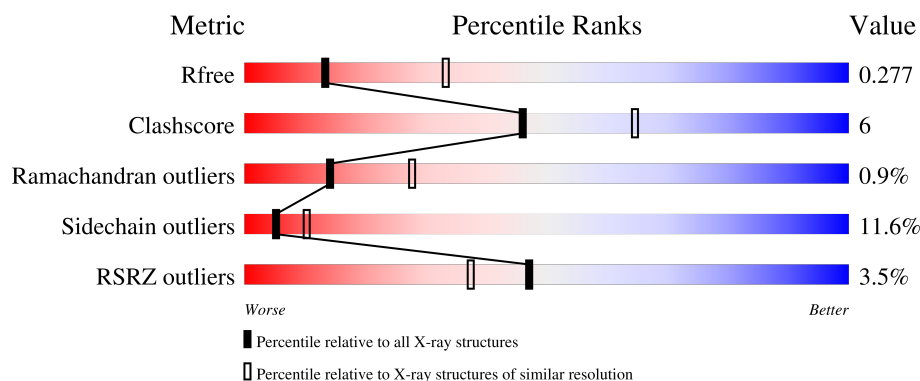
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.85 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	1407 (2.88-2.84)
Clashscore	190562	1446 (2.88-2.84)
Ramachandran outliers	187476	1406 (2.88-2.84)
Sidechain outliers	187428	1407 (2.88-2.84)
RSRZ outliers	180081	1408 (2.88-2.84)

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	190	2% 77% 16% • •
1	B	190	0% 70% 23% • •
2	C	138	8% 55% 17% • • 24%
2	D	138	4% 53% 20% • • 24%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4655 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 Ubiquitin-conjugating enzyme E2-21 kDa.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	182	Total	C	N	O	S	0	0	0
			1470	951	247	267	5			
1	B	182	Total	C	N	O	S	0	0	0
			1470	951	247	267	5			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	GLY	-	expression tag	UNP O60015
A	0	ALA	-	expression tag	UNP O60015
A	1	MET	-	expression tag	UNP O60015
A	2	ALA	-	expression tag	UNP O60015
B	-1	GLY	-	expression tag	UNP O60015
B	0	ALA	-	expression tag	UNP O60015
B	1	MET	-	expression tag	UNP O60015
B	2	ALA	-	expression tag	UNP O60015

- Molecule 2 is a protein called Peroxin 22.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	D	105	Total	C	N	O	S	0	1	0
			856	543	145	167	1			
2	C	105	Total	C	N	O	S	0	1	0
			859	545	147	166	1			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	23	GLY	-	expression tag	UNP A2T0X6
D	24	ALA	-	expression tag	UNP A2T0X6
D	25	MET	-	expression tag	UNP A2T0X6
C	23	GLY	-	expression tag	UNP A2T0X6

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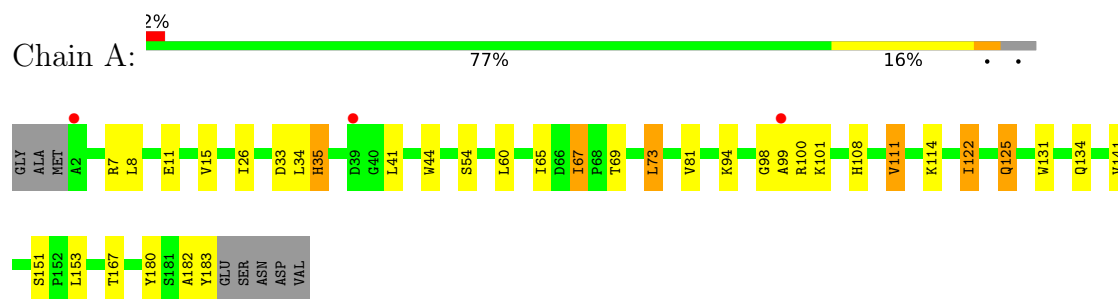
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Chain	Residue	Modelled	Actual	Comment	Reference
C	24	ALA	-	expression tag	UNP A2T0X6
C	25	MET	-	expression tag	UNP A2T0X6

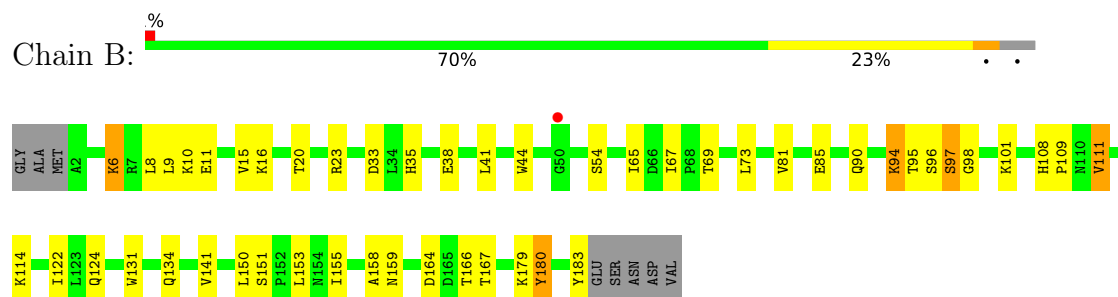
3 Residue-property plots [i](#)

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.

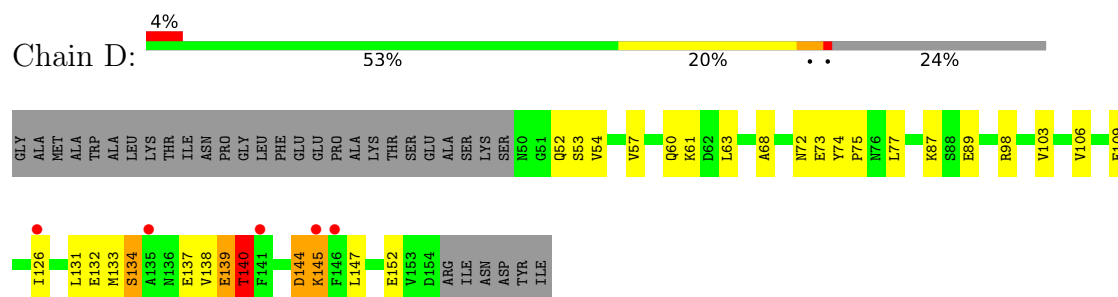
- Molecule 1: Ubiquitin-conjugating enzyme E2-21 kDa



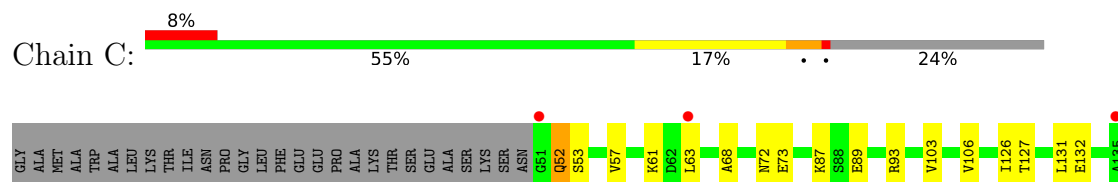
- Molecule 1: Ubiquitin-conjugating enzyme E2-21 kDa



- Molecule 2: Peroxin 22



- Molecule 2: Peroxin 22



M136	E137	V138	E139	T140	F141	H142	L143	D144	K145	F146	L147	T148	M149	V150	H151	E152	V153	D154	R155	ILE	ASN	ASP	TYR	ILE

4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	44.68Å 61.58Å 78.44Å 89.18° 78.02° 84.09°	Depositor
Resolution (Å)	48.04 – 2.85 48.04 – 2.85	Depositor EDS
% Data completeness (in resolution range)	95.0 (48.04-2.85) 95.6 (48.04-2.85)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.32 (at 2.77Å)	Xtriage
Refinement program	REFMAC 5.8.0158	Depositor
R, R_{free}	0.236 , 0.284 0.234 , 0.277	Depositor DCC
R_{free} test set	980 reflections (4.79%)	wwPDB-VP
Wilson B-factor (Å ²)	63.4	Xtriage
Anisotropy	0.304	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 51.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	4655	wwPDB-VP
Average B, all atoms (Å ²)	76.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.92% 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

5.1 Standard geometry

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	1.05	2/1508 (0.1%)	1.19	6/2050 (0.3%)
1	B	1.10	2/1508 (0.1%)	1.22	7/2050 (0.3%)
2	C	0.99	2/874 (0.2%)	1.18	3/1185 (0.3%)
2	D	1.09	1/871 (0.1%)	1.26	7/1182 (0.6%)
All	All	1.06	7/4761 (0.1%)	1.21	23/6467 (0.4%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1
2	C	0	1
2	D	0	1
All	All	0	3

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	151	SER	CA-C	7.35	1.61	1.53
1	A	151	SER	CA-C	7.22	1.61	1.53
1	B	180	TYR	N-CA	5.75	1.52	1.46
2	D	140	THR	CA-C	5.75	1.60	1.52
2	C	141	PHE	CA-C	5.51	1.59	1.53
1	A	182	ALA	C-O	-5.19	1.18	1.24
2	C	53	SER	N-CA	5.07	1.52	1.46

All (23) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	95	THR	N-CA-C	8.02	120.93	111.71
2	D	138	VAL	N-CA-C	-7.69	103.36	110.82

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	6	LYS	CB-CA-C	-7.13	98.96	110.79
2	C	138	VAL	N-CA-C	-7.06	103.97	110.82
1	B	94	LYS	CA-C-N	7.02	130.38	120.28
1	B	94	LYS	C-N-CA	7.02	130.38	120.28
2	C	137	GLU	N-CA-C	-6.72	102.35	111.55
2	D	134	SER	N-CA-C	6.58	124.83	110.80
2	D	140	THR	N-CA-C	6.37	124.36	110.80
2	D	133	MET	CA-C-O	-6.26	114.12	121.06
1	B	180	TYR	N-CA-C	5.94	120.10	112.26
2	C	146	PHE	N-CA-C	-5.89	101.56	110.28
1	B	98	GLY	N-CA-C	5.79	120.97	113.27
1	A	122	ILE	CB-CA-C	-5.78	103.61	112.05
1	A	180	TYR	N-CA-C	5.48	119.60	111.87
1	A	67	ILE	CB-CA-C	-5.45	104.51	110.78
1	A	73	LEU	N-CA-C	-5.42	105.29	111.14
1	A	35	HIS	N-CA-C	5.39	113.07	108.22
2	D	140	THR	CA-C-N	5.38	130.83	122.49
2	D	140	THR	C-N-CA	5.38	130.83	122.49
2	D	63	LEU	N-CA-C	5.26	118.48	111.75
1	B	6	LYS	CA-CB-CG	5.16	124.43	114.10
1	A	122	ILE	N-CA-C	5.05	118.14	111.17

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	125	GLN	Peptide
2	C	141	PHE	Peptide
2	D	140	THR	Peptide

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	1470	0	1496	13	0
1	B	1470	0	1496	17	0
2	C	859	0	848	9	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	D	856	0	841	15	0
All	All	4655	0	4681	54	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 (54) 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:127:THR:HG23	2:C:149:ASN:HB3	1.73	0.70
1:A:60:LEU:CD1	1:A:100:ARG:HD3	2.35	0.57
2:D:152:GLU:HA	2:D:152:GLU:OE1	2.06	0.56
2:D:145:LYS:HE3	2:D:145:LYS:HA	1.89	0.55
1:B:97:SER:HA	1:B:183:TYR:CE2	2.41	0.55
1:A:94:LYS:HA	1:A:94:LYS:HE2	1.88	0.54
2:C:136:ASN:HA	2:C:138:VAL:HG23	1.90	0.54
2:D:144:ASP:OD1	2:D:144:ASP:N	2.40	0.53
2:D:54:VAL:HG13	2:D:77:LEU:CD1	2.38	0.53
1:B:6:LYS:O	1:B:10:LYS:HG3	2.09	0.53
2:C:144:ASP:OD1	2:C:144:ASP:N	2.40	0.53
1:A:44:TRP:HB2	1:A:65:ILE:HB	1.93	0.51
1:A:7:ARG:NH1	1:A:11:GLU:OE2	2.43	0.51
1:A:15:VAL:HG21	1:A:34:LEU:HD23	1.93	0.50
1:B:108:HIS:HB3	1:B:111:VAL:CG1	2.42	0.50
1:B:122:ILE:HD12	1:B:131:TRP:CZ2	2.47	0.50
1:A:15:VAL:HG22	1:A:134:GLN:OE1	2.12	0.49
1:A:108:HIS:HB3	1:A:111:VAL:CG1	2.42	0.49
1:A:11:GLU:O	1:A:15:VAL:HG23	2.11	0.49
2:C:68:ALA:O	2:C:72:ASN:ND2	2.46	0.48
1:B:15:VAL:HG22	1:B:134:GLN:OE1	2.13	0.48
2:D:87:LYS:NZ	2:D:103:VAL:O	2.46	0.48
2:D:152:GLU:OE1	2:D:152:GLU:CA	2.61	0.48
1:B:8:LEU:HD11	1:B:67:ILE:HG21	1.96	0.48
1:B:11:GLU:O	1:B:15:VAL:HG23	2.13	0.47
2:D:54:VAL:HG13	2:D:77:LEU:HD13	1.97	0.47
1:B:38:GLU:OE1	1:B:38:GLU:N	2.49	0.46
1:A:33:ASP:OD1	1:A:35:HIS:HD2	1.98	0.46
2:D:68:ALA:O	2:D:72:ASN:ND2	2.48	0.46
1:B:41:LEU:O	1:B:44:TRP:NE1	2.47	0.45
2:D:52:GLN:HA	2:D:52:GLN:OE1	2.17	0.45
2:D:109:GLU:OE2	2:D:132:GLU:O	2.35	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:C:87:LYS:NZ	2:C:103:VAL:O	2.49	0.45
1:A:8:LEU:HD11	1:A:67:ILE:HG21	1.99	0.45
2:D:52:GLN:HE22	2:D:74:TYR:CA	2.30	0.44
1:A:101:LYS:NZ	1:A:183:TYR:OH	2.44	0.44
2:D:60:GLN:HG2	2:D:61:LYS:HG3	1.99	0.44
2:C:127:THR:HG22	2:C:148:THR:OG1	2.18	0.43
1:B:44:TRP:HB2	1:B:65:ILE:HB	2.00	0.43
2:C:147:LEU:HD13	2:C:147:LEU:HA	1.94	0.43
2:C:146:PHE:O	2:C:147:LEU:HD22	2.19	0.43
1:A:41:LEU:O	1:A:44:TRP:NE1	2.48	0.43
1:B:155:ILE:HG22	1:B:159:ASN:OD1	2.19	0.42
2:D:139:GLU:C	2:D:140:THR:HG1	2.27	0.42
1:B:33:ASP:OD1	1:B:35:HIS:HD2	2.02	0.42
1:A:122:ILE:HD12	1:A:131:TRP:CZ2	2.55	0.42
1:B:108:HIS:HB3	1:B:111:VAL:HG13	2.02	0.41
1:B:179:LYS:HD3	1:B:180:TYR:CZ	2.55	0.41
1:B:109:PRO:HB3	1:B:158:ALA:HB2	2.03	0.41
1:B:101:LYS:HG3	1:B:183:TYR:CZ	2.55	0.41
2:D:54:VAL:HG13	2:D:77:LEU:HD12	2.01	0.41
2:C:52:GLN:HE21	2:C:52:GLN:HB3	1.69	0.41
1:B:16:LYS:O	1:B:20:THR:HG23	2.21	0.41
2:D:52:GLN:NE2	2:D:75:PRO:HD2	2.37	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	180/190 (95%)	165 (92%)	13 (7%)	2 (1%)	11	24
1	B	180/190 (95%)	169 (94%)	11 (6%)	0	100	100
2	C	104/138 (75%)	92 (88%)	12 (12%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	D	104/138 (75%)	87 (84%)	14 (14%)	3 (3%)	3	8
All	All	568/656 (87%)	513 (90%)	50 (9%)	5 (1%)	14	28

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	99	ALA
2	D	140	THR
1	A	98	GLY
2	D	53	SER
2	D	139	GLU

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	163/169 (96%)	152 (93%)	11 (7%)	15	31
1	B	163/169 (96%)	143 (88%)	20 (12%)	4	8
2	C	101/126 (80%)	84 (83%)	17 (17%)	2	3
2	D	101/126 (80%)	88 (87%)	13 (13%)	4	7
All	All	528/590 (90%)	467 (88%)	61 (12%)	5	10

All (61) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	26	ILE
1	A	54	SER
1	A	69	THR
1	A	73	LEU
1	A	81	VAL
1	A	111	VAL
1	A	114	LYS
1	A	125	GLN
1	A	141	VAL

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Mol	Chain	Res	Type
1	A	153	LEU
1	A	167	THR
2	D	57	VAL
2	D	73	GLU
2	D	89	GLU
2	D	98	ARG
2	D	106	VAL
2	D	126	ILE
2	D	131	LEU
2	D	134	SER
2	D	137	GLU
2	D	140	THR
2	D	144	ASP
2	D	145	LYS
2	D	147	LEU
2	C	52	GLN
2	C	57	VAL
2	C	61	LYS
2	C	63	LEU
2	C	73	GLU
2	C	89	GLU
2	C	93	ARG
2	C	106	VAL
2	C	126	ILE
2	C	131	LEU
2	C	132	GLU
2	C	139	GLU
2	C	140	THR
2	C	141	PHE
2	C	144	ASP
2	C	147	LEU
2	C	155	ARG
1	B	9	LEU
1	B	23	ARG
1	B	54	SER
1	B	69	THR
1	B	73	LEU
1	B	81	VAL
1	B	85	GLU
1	B	90	GLN
1	B	94	LYS
1	B	96	SER

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Mol	Chain	Res	Type
1	B	97	SER
1	B	111	VAL
1	B	114	LYS
1	B	124	GLN
1	B	141	VAL
1	B	150	LEU
1	B	153	LEU
1	B	164	ASP
1	B	166	THR
1	B	167	THR

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	35	HIS
2	D	72	ASN
2	D	102	GLN
2	D	130	ASN
2	D	151	HIS
2	C	72	ASN
2	C	102	GLN
2	C	130	ASN
1	B	35	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	182/190 (95%)	0.07	3 (1%) 70 64	48, 69, 108, 141	0
1	B	182/190 (95%)	0.09	1 (0%) 87 85	46, 68, 113, 143	0
2	C	105/138 (76%)	0.54	11 (10%) 11 9	38, 85, 114, 124	1 (0%)
2	D	105/138 (76%)	0.25	5 (4%) 35 28	27, 69, 97, 112	1 (0%)
All	All	574/656 (87%)	0.19	20 (3%) 47 37	27, 72, 112, 143	2 (0%)

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	2	ALA	4.0
2	D	146	PHE	3.5
2	C	150	VAL	3.3
2	C	153	VAL	3.2
2	C	149	ASN	3.2
2	C	146	PHE	2.8
2	C	152	GLU	2.6
2	D	126	ILE	2.5
1	A	39	ASP	2.4
1	B	50	GLY	2.4
1	A	99	ALA	2.4
2	C	135	ALA	2.3
2	D	141	PHE	2.2
2	D	145	LYS	2.2
2	C	51	GLY	2.2
2	C	147	LEU	2.1
2	C	141	PHE	2.1
2	C	63	LEU	2.0
2	D	135	ALA	2.0
2	C	143	LEU	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.