



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 01:53 PM UTC

PDB ID : 5TRU / pdb_00005tru
Title : Structure of the first-in-class checkpoint inhibitor Ipilimumab bound to human CTLA-4
Authors : Ramagopal, U.A.; Liu, W.; Garrett-Thomson, S.C.; Yan, Q.; Srinivasan, M.; Wong, S.C.; Bell, A.; Mankikar, S.; Rangan, V.S.; Deshpande, S.; Bonanno, J.B.; Korman, A.J.; Almo, S.C.
Deposited on : 2016-10-27
Resolution : 3.00 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:

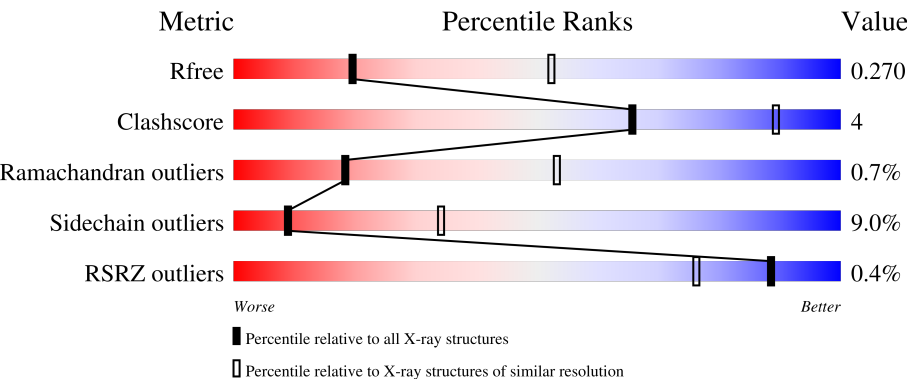
MolProbity	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 3.00 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	2672 (3.00-3.00)
Clashscore	190562	2977 (3.00-3.00)
Ramachandran outliers	187476	2877 (3.00-3.00)
Sidechain outliers	187428	2880 (3.00-3.00)
RSRZ outliers	180081	2671 (3.00-3.00)

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	L	215	
1	l	215	
2	H	225	
2	h	225	
3	C	118	

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Mol	Chain	Length	Quality of chain
3	c	118	% 84% 13% ..

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 8036 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 Ipilimumab Fab light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	L	213	Total	C	N	O	S	0	0	0
			1627	1023	275	325	4			
1	l	212	Total	C	N	O	S	0	0	0
			1579	987	271	317	4			

- Molecule 2 is a protein called Ipilimumab Fab heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	H	215	Total	C	N	O	S	0	0	0
			1619	1030	270	313	6			
2	h	212	Total	C	N	O	S	0	0	0
			1589	1011	266	306	6			

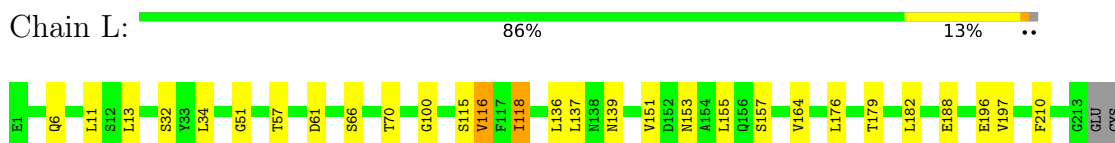
- Molecule 3 is a protein called Cytotoxic T-lymphocyte protein 4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	c	115	Total	C	N	O	S	0	0	0
			816	515	134	158	9			
3	C	114	Total	C	N	O	S	0	0	0
			806	510	132	155	9			

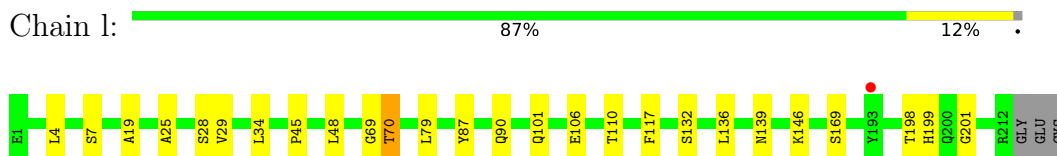
3 Residue-property plots

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.

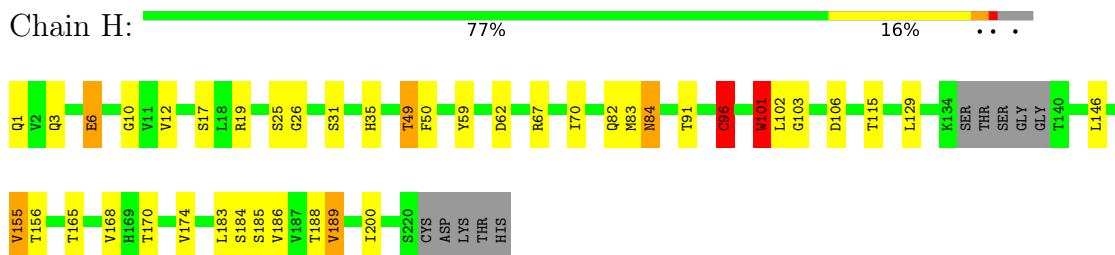
- Molecule 1: Ipilimumab Fab light chain



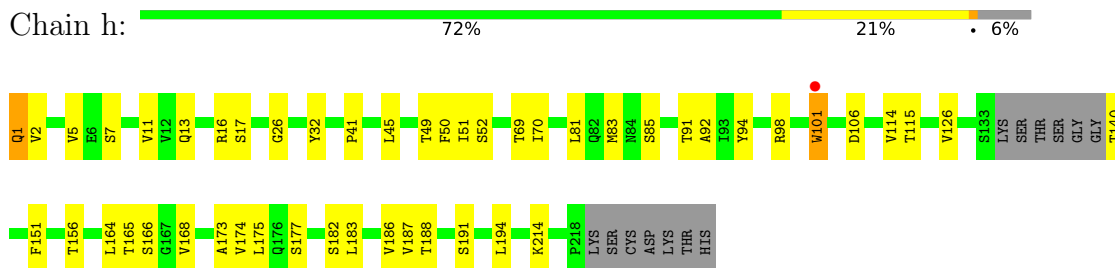
- Molecule 1: Ipilimumab Fab light chain



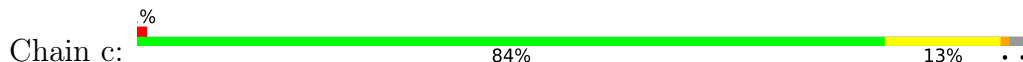
- Molecule 2: Ipilimumab Fab heavy chain

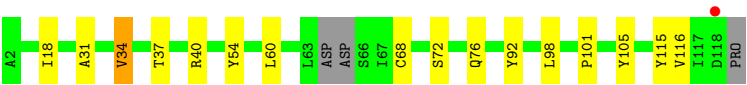


- Molecule 2: Ipilimumab Fab heavy chain

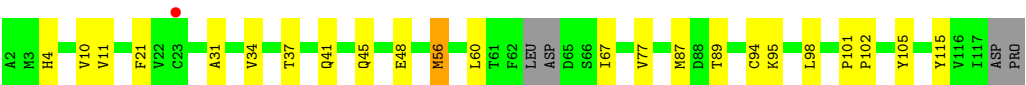
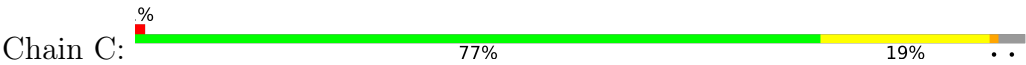


- Molecule 3: Cytotoxic T-lymphocyte protein 4





● Molecule 3: Cytotoxic T-lymphocyte protein 4



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	95.84Å 197.50Å 148.12Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	34.91 – 3.00 34.91 – 3.00	Depositor EDS
% Data completeness (in resolution range)	99.2 (34.91-3.00) 99.3 (34.91-3.00)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.67 (at 3.00Å)	Xtriage
Refinement program	REFMAC 5	Depositor
R, R_{free}	0.203 , 0.268 0.206 , 0.270	Depositor DCC
R_{free} test set	1447 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	62.1	Xtriage
Anisotropy	0.607	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.27 , 28.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	8036	wwPDB-VP
Average B, all atoms (Å ²)	71.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.45% 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	L	0.64	0/1665	0.94	1/2263 (0.0%)
1	l	0.64	0/1616	0.92	0/2200
2	H	0.69	0/1661	1.02	7/2268 (0.3%)
2	h	0.66	0/1631	0.94	3/2229 (0.1%)
3	C	0.69	0/819	0.98	1/1118 (0.1%)
3	c	0.67	0/828	0.89	0/1129
All	All	0.66	0/8220	0.95	12/11207 (0.1%)

There are no bond length outliers.

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	H	84	ASN	N-CA-C	7.23	122.55	112.93
2	H	10	GLY	N-CA-C	6.25	117.88	111.56
2	h	106	ASP	N-CA-C	6.01	117.63	111.14
3	C	56	MET	N-CA-C	5.91	117.30	108.31
2	H	96	CYS	N-CA-C	-5.89	100.09	109.76
2	H	49	THR	N-CA-C	5.79	117.91	108.76
2	h	2	VAL	N-CA-C	5.44	116.59	108.54
1	L	100	GLY	N-CA-C	-5.41	104.33	112.60
2	H	103	GLY	N-CA-C	5.39	123.34	112.34
2	H	189	VAL	N-CA-C	5.33	115.03	109.01
2	H	106	ASP	N-CA-C	5.27	117.10	111.36
2	h	126	VAL	N-CA-C	5.15	114.17	106.85

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	L	1627	0	1571	8	0
1	l	1579	0	1463	9	0
2	H	1619	0	1544	15	0
2	h	1589	0	1523	17	0
3	C	806	0	748	9	0
3	c	816	0	776	7	0
All	All	8036	0	7625	60	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 4.

All (60) 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:L:137:LEU:HD21	1:L:197:VAL:HG11	1.33	1.08
3:c:98:LEU:HD12	3:c:105:TYR:HB2	1.77	0.66
3:c:34:VAL:HG23	3:c:54:TYR:HB3	1.77	0.66
3:C:31:ALA:HA	3:C:101:PRO:HD2	1.78	0.65
1:l:117:PHE:HB2	1:l:136:LEU:HB3	1.77	0.65
2:H:165:THR:O	2:H:168:VAL:HG12	1.97	0.64
2:H:6:GLU:OE1	2:H:96:CYS:HB3	1.97	0.63
2:H:101:TRP:HE3	2:H:102:LEU:H	1.49	0.61
1:l:4:LEU:HD23	1:l:25:ALA:HB2	1.81	0.60
2:H:67:ARG:O	2:H:84:ASN:HB2	2.02	0.60
3:C:60:LEU:HD11	3:C:77:VAL:HG23	1.84	0.59
3:c:31:ALA:HA	3:c:101:PRO:HD2	1.84	0.58
2:H:3:GLN:HB3	2:H:25:SER:HB2	1.85	0.57
2:H:129:LEU:HD21	2:H:146:LEU:HB2	1.86	0.56
3:C:98:LEU:HD12	3:C:105:TYR:HB2	1.87	0.55
1:L:116:VAL:HG21	1:L:197:VAL:HG21	1.87	0.55
2:H:49:THR:HG23	2:H:70:ILE:HD12	1.90	0.54
2:h:140:THR:N	2:h:191:SER:HG	2.06	0.53
2:H:170:THR:HA	2:H:185:SER:HA	1.94	0.50
2:h:81:LEU:HG	2:h:83:MET:HG2	1.95	0.49
2:H:1:GLN:O	2:H:26:GLY:HA3	2.12	0.49
1:l:117:PHE:CD2	1:l:136:LEU:HD23	2.48	0.48
2:h:11:VAL:HG21	2:h:151:PHE:CE2	2.48	0.48
2:H:17:SER:HB2	2:H:83:MET:O	2.14	0.48
1:L:11:LEU:HD22	1:L:13:LEU:HD11	1.94	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:l:45:PRO:HG2	2:h:45:LEU:HD11	1.97	0.47
1:l:48:LEU:HD11	1:l:87:TYR:HE2	1.81	0.45
2:h:1:GLN:O	2:h:26:GLY:HA3	2.16	0.45
2:h:191:SER:HA	2:h:194:LEU:HD13	1.97	0.45
1:L:32:SER:O	1:L:51:GLY:HA2	2.17	0.45
3:c:40:ARG:HD3	3:c:92:TYR:CZ	2.52	0.45
3:c:115:TYR:CE2	3:C:10:VAL:HG21	2.52	0.45
2:H:35:HIS:CE1	2:H:50:PHE:HD2	2.35	0.45
1:l:136:LEU:HD13	2:h:186:VAL:HG21	1.98	0.45
3:C:37:THR:HB	3:C:95:LYS:HB3	2.00	0.44
3:c:115:TYR:CZ	3:C:10:VAL:HG21	2.52	0.44
2:H:91:THR:HG23	2:H:115:THR:HA	1.99	0.44
2:h:83:MET:HE1	2:h:114:VAL:HG21	1.99	0.43
2:h:13:GLN:HB2	2:h:16:ARG:HG3	2.00	0.43
1:l:28:SER:HA	1:l:70:THR:HG22	1.99	0.43
2:h:173:ALA:HB2	2:h:183:LEU:HD23	2.00	0.43
1:l:199:HIS:CD2	1:l:201:GLY:H	2.36	0.43
2:h:173:ALA:HA	2:h:183:LEU:HB3	2.01	0.43
1:L:116:VAL:HG21	1:L:197:VAL:CG2	2.49	0.42
2:h:91:THR:HG23	2:h:115:THR:HA	2.02	0.42
2:h:92:ALA:HB3	2:h:94:TYR:CE1	2.54	0.42
2:h:32:TYR:HB3	2:h:98:ARG:HD3	2.01	0.42
3:C:89:THR:HG23	3:C:115:TYR:HA	2.03	0.41
2:H:19:ARG:HD3	2:H:82:GLN:NE2	2.36	0.41
3:c:60:LEU:HD22	3:c:72:SER:HB3	2.02	0.41
2:h:49:THR:HG23	2:h:70:ILE:HD12	2.02	0.41
2:H:155:VAL:HG12	2:H:183:LEU:HD21	2.01	0.41
2:h:11:VAL:HG21	2:h:151:PHE:HE2	1.86	0.41
1:L:116:VAL:HA	1:L:136:LEU:O	2.22	0.40
2:H:59:TYR:CE2	3:C:102:PRO:HG3	2.57	0.40
1:L:164:VAL:HG22	1:L:176:LEU:HD12	2.03	0.40
3:C:11:VAL:HG21	3:C:21:PHE:HB3	2.03	0.40
1:L:118:ILE:HG12	1:L:210:PHE:HD1	1.86	0.40
2:h:164:LEU:HD21	2:h:187:VAL:HG21	2.03	0.40
1:l:19:ALA:HB2	1:l:79:LEU:HD11	2.04	0.40

There are no symmetry-related clashes.

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	L	211/215 (98%)	199 (94%)	11 (5%)	1 (0%)	24	60
1	l	210/215 (98%)	201 (96%)	7 (3%)	2 (1%)	12	45
2	H	211/225 (94%)	196 (93%)	14 (7%)	1 (0%)	24	60
2	h	208/225 (92%)	196 (94%)	9 (4%)	3 (1%)	9	36
3	C	110/118 (93%)	104 (94%)	6 (6%)	0	100	100
3	c	111/118 (94%)	100 (90%)	11 (10%)	0	100	100
All	All	1061/1116 (95%)	996 (94%)	58 (6%)	7 (1%)	18	53

All (7) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	H	101	TRP
2	h	101	TRP
1	l	139	ASN
2	h	41	PRO
1	L	139	ASN
1	l	69	GLY
2	h	52	SER

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	L	180/185 (97%)	163 (91%)	17 (9%)	8	32

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	l	166/185 (90%)	154 (93%)	12 (7%)	13	43
2	H	174/191 (91%)	160 (92%)	14 (8%)	11	38
2	h	173/191 (91%)	154 (89%)	19 (11%)	6	25
3	C	78/97 (80%)	69 (88%)	9 (12%)	5	24
3	c	82/97 (84%)	76 (93%)	6 (7%)	13	42
All	All	853/946 (90%)	776 (91%)	77 (9%)	9	34

All (77) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	L	6	GLN
1	L	34	LEU
1	L	57	THR
1	L	61	ASP
1	L	66	SER
1	L	70	THR
1	L	115	SER
1	L	116	VAL
1	L	118	ILE
1	L	151	VAL
1	L	153	ASN
1	L	155	LEU
1	L	157	SER
1	L	179	THR
1	L	182	LEU
1	L	188	GLU
1	L	196	GLU
2	H	6	GLU
2	H	12	VAL
2	H	31	SER
2	H	62	ASP
2	H	96	CYS
2	H	101	TRP
2	H	155	VAL
2	H	156	THR
2	H	174	VAL
2	H	184	SER
2	H	186	VAL
2	H	188	THR
2	H	189	VAL

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Mol	Chain	Res	Type
2	H	200	ILE
1	l	7	SER
1	l	29	VAL
1	l	34	LEU
1	l	70	THR
1	l	90	GLN
1	l	101	GLN
1	l	106	GLU
1	l	110	THR
1	l	132	SER
1	l	146	LYS
1	l	169	SER
1	l	198	THR
2	h	1	GLN
2	h	5	VAL
2	h	7	SER
2	h	17	SER
2	h	50	PHE
2	h	51	ILE
2	h	69	THR
2	h	85	SER
2	h	101	TRP
2	h	156	THR
2	h	165	THR
2	h	166	SER
2	h	168	VAL
2	h	174	VAL
2	h	175	LEU
2	h	177	SER
2	h	182	SER
2	h	188	THR
2	h	214	LYS
3	c	18	ILE
3	c	34	VAL
3	c	37	THR
3	c	68	CYS
3	c	76	GLN
3	c	116	VAL
3	C	4	HIS
3	C	34	VAL
3	C	41	GLN
3	C	45	GLN

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Mol	Chain	Res	Type
3	C	48	GLU
3	C	56	MET
3	C	67	ILE
3	C	87	MET
3	C	94	CYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (15) such sidechains are listed below:

Mol	Chain	Res	Type
1	L	39	GLN
1	L	161	GLN
1	L	200	GLN
1	L	211	ASN
2	H	13	GLN
2	H	39	GLN
2	H	82	GLN
1	l	90	GLN
1	l	138	ASN
1	l	139	ASN
1	l	156	GLN
1	l	211	ASN
2	h	169	HIS
3	c	4	HIS
3	c	75	ASN

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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	L	213/215 (99%)	-0.59	0 100 100	45, 59, 73, 81	0
1	l	212/215 (98%)	-0.36	1 (0%) 87 72	45, 68, 132, 149	0
2	H	215/225 (95%)	-0.52	0 100 100	48, 63, 91, 109	0
2	h	212/225 (94%)	-0.36	1 (0%) 87 72	46, 65, 108, 125	0
3	C	114/118 (96%)	-0.10	1 (0%) 81 61	60, 84, 108, 126	0
3	c	115/118 (97%)	-0.10	1 (0%) 81 61	57, 84, 112, 134	0
All	All	1081/1116 (96%)	-0.38	4 (0%) 88 76	45, 66, 115, 149	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	h	101	TRP	3.1
1	l	193	TYR	2.7
3	c	118	ASP	2.3
3	C	23	CYS	2.1

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.