



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 04:20 PM UTC

PDB ID : 8DTX / pdb_00008dtx
Title : Crystal structure of SARS-CoV-2 spike stem helix peptide in complex with neutralizing antibody COV89-22
Authors : Lin, T.H.; Lee, C.C.D.; Wilson, I.A.
Deposited on : 2022-07-26
Resolution : 1.60 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

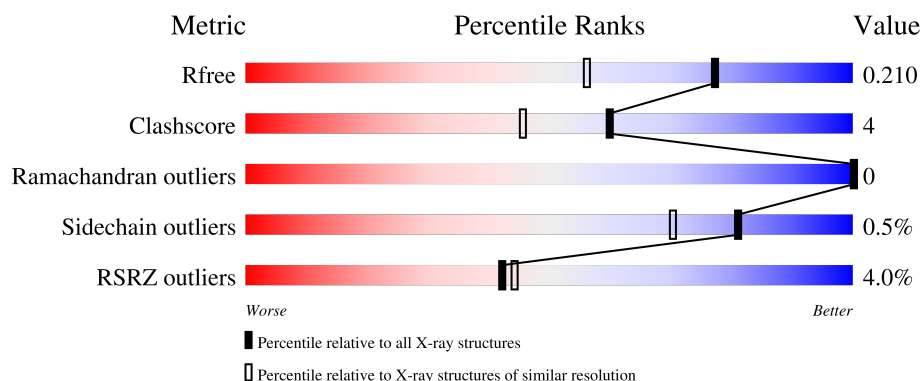
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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	4673 (1.60-1.60)
Clashscore	190562	4931 (1.60-1.60)
Ramachandran outliers	187476	4831 (1.60-1.60)
Sidechain outliers	187428	4830 (1.60-1.60)
RSRZ outliers	180081	4672 (1.60-1.60)

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	221	2% 94% 6%
1	H	221	7% 90% 10%
2	B	217	3% 94% 6%
2	L	217	3% 90% 10%
3	G	15	13% 87% 13%

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Mol	Chain	Length	Quality of chain
3	I	15	7% 100%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 7998 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 COV89-22 heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	H	221	Total	C	N	O	S	0	0	0
			1659	1043	285	322	9			
1	A	221	Total	C	N	O	S	0	0	0
			1659	1043	285	322	9			

- Molecule 2 is a protein called COV89-22 light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	L	216	Total	C	N	O	S	0	0	0
			1686	1055	289	337	5			
2	B	216	Total	C	N	O	S	0	0	0
			1686	1055	289	337	5			

- Molecule 3 is a protein called Spike protein S2' stem helix peptide.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	I	15	Total	C	N	O	0	0	0
			135	88	21	26			
3	G	15	Total	C	N	O	0	0	0
			135	88	21	26			

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	H	245	Total	O	0	0
			245	245		
4	L	227	Total	O	0	0
			227	227		
4	I	16	Total	O	0	0
			16	16		
4	A	282	Total	O	0	0
			282	282		

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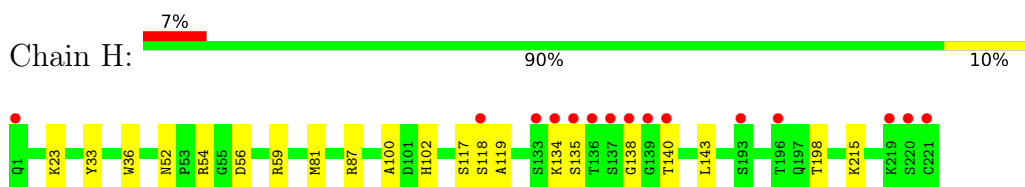
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	250	Total 250	O 250	0	0
4	G	18	Total 18	O 18	0	0

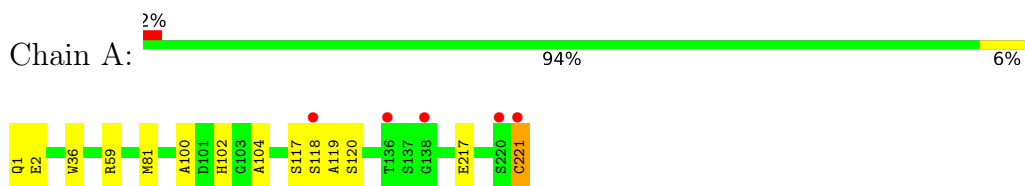
3 Residue-property plots

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.

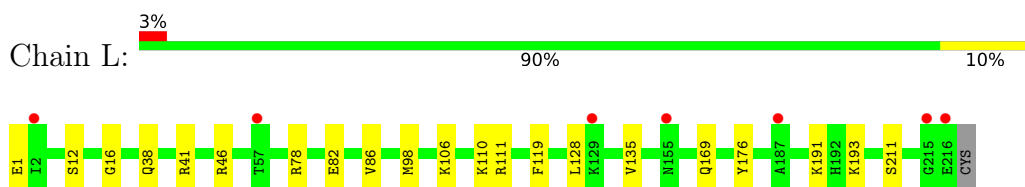
- Molecule 1: COV89-22 heavy chain



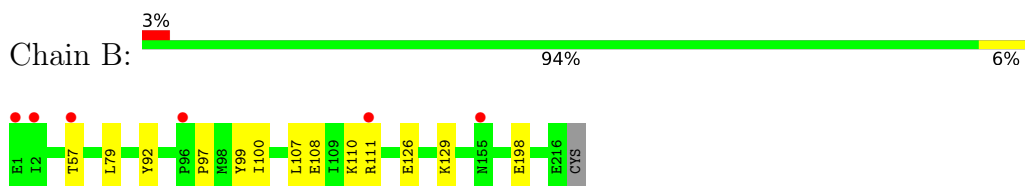
- Molecule 1: COV89-22 heavy chain



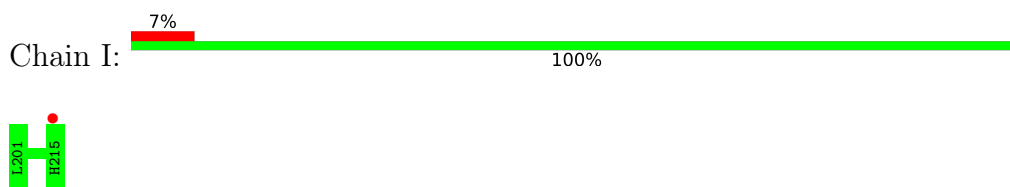
- Molecule 2: COV89-22 light chain



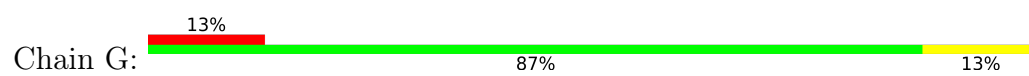
- Molecule 2: COV89-22 light chain



- Molecule 3: Spike protein S2' stem helix peptide



- Molecule 3: Spike protein S2' stem helix peptide



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	42.09Å 76.92Å 154.38Å 90.00° 93.78° 90.00°	Depositor
Resolution (Å)	42.71 – 1.60 42.71 – 1.60	Depositor EDS
% Data completeness (in resolution range)	77.1 (42.71-1.60) 69.5 (42.71-1.60)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.18 (at 1.60Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.185 , 0.210 0.185 , 0.210	Depositor DCC
R_{free} test set	4973 reflections (3.85%)	wwPDB-VP
Wilson B-factor (Å ²)	20.4	Xtriage
Anisotropy	0.275	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 31.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	7998	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.94% 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	0.28	0/1698	0.49	0/2304
1	H	0.23	0/1698	0.48	0/2304
2	B	0.21	0/1722	0.48	0/2334
2	L	0.21	0/1722	0.46	0/2334
3	G	0.16	0/138	0.39	0/182
3	I	0.15	0/138	0.36	0/182
All	All	0.23	0/7116	0.47	0/9640

There are no bond length outliers.

There are no bond angle outliers.

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	1659	0	1627	14	0
1	H	1659	0	1627	16	0
2	B	1686	0	1637	12	0
2	L	1686	0	1637	19	0
3	G	135	0	125	3	0
3	I	135	0	125	0	0
4	A	282	0	0	7	3
4	B	250	0	0	3	5
4	G	18	0	0	0	0
4	H	245	0	0	5	1

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	I	16	0	0	0	0
4	L	227	0	0	5	0
All	All	7998	0	6778	59	6

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 (59) 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:H:140:THR:OG1	4:H:301:HOH:O	1.84	0.96
2:L:82:GLU:OE2	4:L:301:HOH:O	1.84	0.93
1:H:138:GLY:O	4:H:303:HOH:O	2.02	0.77
2:L:1:GLU:OE2	4:L:302:HOH:O	2.01	0.76
1:H:59:ARG:HH12	2:L:98:MET:HE2	1.50	0.74
1:H:135:SER:OG	4:H:302:HOH:O	1.99	0.72
2:B:57:THR:O	4:B:301:HOH:O	2.08	0.71
1:A:117:SER:HG	1:A:119:ALA:N	1.89	0.69
2:B:110:LYS:O	2:B:111:ARG:N	2.26	0.68
1:A:2:GLU:OE2	4:A:302:HOH:O	2.14	0.65
2:B:126:GLU:OE2	4:B:303:HOH:O	2.15	0.63
1:H:117:SER:HG	1:H:119:ALA:N	1.98	0.61
1:H:87:ARG:NH1	4:H:307:HOH:O	2.34	0.60
2:L:110:LYS:HA	2:L:111:ARG:N	2.20	0.56
1:H:23:LYS:NZ	4:H:310:HOH:O	2.38	0.56
1:A:102:HIS:CE1	1:A:104:ALA:HB3	2.43	0.54
2:L:169:GLN:HG3	2:L:176:TYR:CZ	2.43	0.53
2:B:198:GLU:HG3	4:B:311:HOH:O	2.09	0.52
2:L:16:GLY:O	2:L:78:ARG:HG3	2.10	0.51
1:H:36:TRP:CE2	1:H:81:MET:HB2	2.46	0.51
1:H:118:SER:O	1:H:119:ALA:N	2.46	0.49
2:B:110:LYS:HA	2:B:111:ARG:N	2.28	0.48
2:L:78:ARG:NH1	4:L:309:HOH:O	2.46	0.48
2:L:41:ARG:NH2	4:L:312:HOH:O	2.47	0.47
1:A:221:CYS:O	4:A:303:HOH:O	2.20	0.47
1:A:100:ALA:HB3	1:A:102:HIS:CE1	2.49	0.47
2:L:110:LYS:O	2:L:111:ARG:N	2.47	0.46
2:L:12:SER:HB3	2:L:110:LYS:HB2	1.97	0.46
2:B:111:ARG:HH11	2:B:111:ARG:HG2	1.81	0.46
1:A:221:CYS:HA	4:A:303:HOH:O	2.15	0.45
2:L:16:GLY:HA2	2:L:78:ARG:HG2	1.97	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:L:86:VAL:HG22	2:L:106:LYS:HE2	1.97	0.45
2:B:126:GLU:HA	2:B:129:LYS:HD2	1.98	0.45
1:A:36:TRP:CE2	1:A:81:MET:HB2	2.52	0.44
2:B:99:TYR:C	2:B:100:ILE:HD13	2.42	0.44
1:H:198:THR:HG23	1:H:215:LYS:HE3	2.00	0.44
1:A:81:MET:HE3	1:A:81:MET:HB3	1.78	0.44
1:H:33:TYR:CD2	1:H:52:ASN:HA	2.53	0.43
2:B:92:TYR:HD2	3:G:1148:PHE:CE1	2.37	0.43
1:A:1:GLN:OE1	1:A:1:GLN:N	2.47	0.43
1:A:120:SER:OG	4:A:301:HOH:O	2.11	0.43
2:L:38:GLN:OE1	2:L:46:ARG:NH2	2.52	0.43
1:A:118:SER:O	1:A:119:ALA:N	2.52	0.42
1:H:100:ALA:HB3	1:H:102:HIS:CE1	2.55	0.42
1:H:81:MET:HE3	1:H:81:MET:HB3	1.95	0.42
1:A:59:ARG:HG3	2:B:97:PRO:HD2	2.02	0.42
2:B:110:LYS:C	2:B:111:ARG:N	2.77	0.42
2:B:79:LEU:HD21	2:B:107:LEU:HD21	2.02	0.41
1:A:102:HIS:HE1	1:A:104:ALA:HB3	1.82	0.41
1:H:54:ARG:HG2	1:H:56:ASP:CG	2.45	0.41
2:L:191:LYS:NZ	2:L:191:LYS:HB3	2.36	0.41
2:L:193:LYS:HA	2:L:193:LYS:HD3	1.83	0.41
1:H:134:LYS:HD2	2:L:211:SER:O	2.21	0.41
1:A:217:GLU:HG2	4:A:369:HOH:O	2.21	0.41
4:A:306:HOH:O	3:G:1149:LYS:HE3	2.20	0.40
4:A:306:HOH:O	3:G:1149:LYS:CE	2.68	0.40
2:L:78:ARG:HB3	4:L:324:HOH:O	2.22	0.40
1:H:135:SER:HA	2:L:119:PHE:HD2	1.86	0.40
2:L:128:LEU:HD23	2:L:128:LEU:HA	1.93	0.40

All (6) 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)
4:A:307:HOH:O	4:B:412:HOH:O[1_565]	1.81	0.39
4:B:347:HOH:O	4:B:456:HOH:O[2_444]	1.99	0.21
4:B:344:HOH:O	4:B:453:HOH:O[2_444]	2.10	0.10
4:B:310:HOH:O	4:B:437:HOH:O[2_444]	2.16	0.04
4:H:489:HOH:O	4:A:359:HOH:O[1_655]	2.19	0.01
4:A:538:HOH:O	4:B:313:HOH:O[1_455]	2.19	0.01

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	217/221 (98%)	215 (99%)	2 (1%)	0	100	100
1	H	217/221 (98%)	214 (99%)	3 (1%)	0	100	100
2	B	212/217 (98%)	207 (98%)	5 (2%)	0	100	100
2	L	212/217 (98%)	209 (99%)	3 (1%)	0	100	100
3	G	13/15 (87%)	13 (100%)	0	0	100	100
3	I	13/15 (87%)	13 (100%)	0	0	100	100
All	All	884/906 (98%)	871 (98%)	13 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	184/184 (100%)	183 (100%)	1 (0%)	81	70
1	H	184/184 (100%)	183 (100%)	1 (0%)	81	70
2	B	189/190 (100%)	188 (100%)	1 (0%)	81	70
2	L	189/190 (100%)	188 (100%)	1 (0%)	81	70
3	G	15/15 (100%)	15 (100%)	0	100	100
3	I	15/15 (100%)	15 (100%)	0	100	100
All	All	776/778 (100%)	772 (100%)	4 (0%)	81	70

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	H	143	LEU
2	L	135	VAL
1	A	221	CYS
2	B	108	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	H	39	GLN
2	L	39	GLN
3	I	214	ASN
3	I	215	HIS
1	A	3	GLN
1	A	102	HIS
2	B	27	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

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	H	1
2	L	1
1	A	1
2	B	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	H	118:SER	C	119:ALA	N	2.83
1	L	110:LYS	C	111:ARG	N	2.81
1	A	118:SER	C	119:ALA	N	2.81
1	B	110:LYS	C	111:ARG	N	2.77

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	221/221 (100%)	0.04	5 (2%) 61 64	15, 23, 35, 49	0
1	H	221/221 (100%)	0.25	15 (6%) 23 24	14, 23, 47, 72	0
2	B	216/217 (99%)	0.10	6 (2%) 55 58	14, 23, 38, 58	0
2	L	216/217 (99%)	0.26	7 (3%) 50 53	14, 24, 40, 55	0
3	G	15/15 (100%)	0.90	2 (13%) 7 7	26, 36, 48, 54	0
3	I	15/15 (100%)	0.74	1 (6%) 24 24	23, 32, 46, 49	0
All	All	904/906 (99%)	0.18	36 (3%) 42 44	14, 23, 41, 72	0

All (36) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	H	221	CYS	5.0
1	H	220	SER	4.0
1	A	221	CYS	3.9
1	H	196	THR	3.6
1	H	1	GLN	3.3
1	H	135	SER	3.3
1	H	138	GLY	3.2
1	H	136	THR	3.2
1	H	134	LYS	3.0
1	H	140	THR	2.9
1	H	118	SER	2.8
2	B	2	ILE	2.7
3	G	1159	HIS	2.7
3	I	215	HIS	2.6
1	H	139	GLY	2.6
1	H	193	SER	2.6
1	A	118	SER	2.6
1	A	138	GLY	2.6
1	H	133	SER	2.5

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Mol	Chain	Res	Type	RSRZ
2	L	187	ALA	2.5
2	B	57	THR	2.5
1	H	219	LYS	2.4
1	A	220	SER	2.3
1	H	137	SER	2.3
2	L	155	ASN	2.2
3	G	1145	LEU	2.2
1	A	136	THR	2.2
2	L	215	GLY	2.2
2	B	155	ASN	2.2
2	B	111	ARG	2.1
2	B	96	PRO	2.1
2	L	2	ILE	2.1
2	L	129	LYS	2.1
2	B	1	GLU	2.1
2	L	57	THR	2.1
2	L	216	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.