Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 02:16 PM EDT

PDB ID	:	9PKQ / pdb_00009pkq
Title	:	Structure of the cytoplasmic domain of unliganded human Tom70, open and closed conformations
Authors	:	Bachochin, M.J.; McGuire, K.L.; Cook, B.D.; Ye, Q.; Silletti, S.; Corbett, K.D.; Komives, E.A.; Herzik Jr., M.A.
Deposited on	:	2025-07-14
Resolution	:	2.00 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:

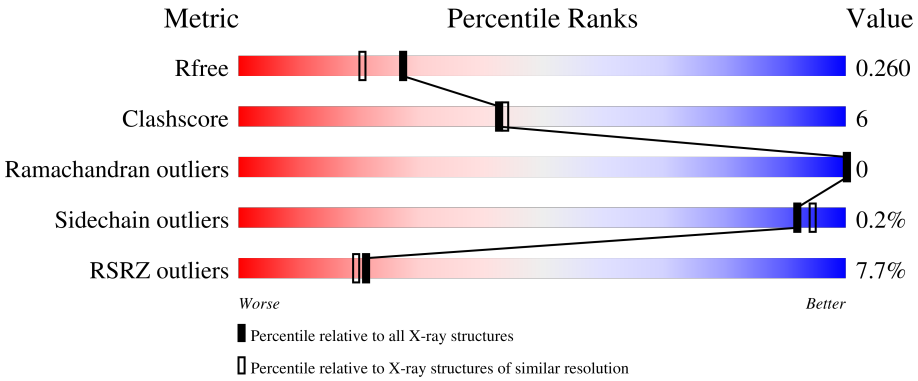
MolProbity	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.48.1

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 2.00 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}	164625	9409 (2.00-2.00)
Clashscore	180529	10737 (2.00-2.00)
Ramachandran outliers	177936	10628 (2.00-2.00)
Sidechain outliers	177891	10627 (2.00-2.00)
RSRZ outliers	164620	9409 (2.00-2.00)

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 <=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	510	8% 84% 12% 5%
1	B	510	7% 85% 10% 5%

2 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 15702 atoms, of which 7730 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 Mitochondrial import receptor subunit TOM70.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	486	Total	C	H	N	O	S	0	1	0
			7753	2449	3877	657	743	27			
1	B	483	Total	C	H	N	O	S	0	3	0
			7721	2438	3853	654	749	27			

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	609	ILE	-	expression tag	UNP O94826
A	610	GLY	-	expression tag	UNP O94826
A	611	GLY	-	expression tag	UNP O94826
A	612	LEU	-	expression tag	UNP O94826
A	613	GLU	-	expression tag	UNP O94826
A	614	VAL	-	expression tag	UNP O94826
A	615	LEU	-	expression tag	UNP O94826
A	616	PHE	-	expression tag	UNP O94826
A	617	GLN	-	expression tag	UNP O94826
B	609	ILE	-	expression tag	UNP O94826
B	610	GLY	-	expression tag	UNP O94826
B	611	GLY	-	expression tag	UNP O94826
B	612	LEU	-	expression tag	UNP O94826
B	613	GLU	-	expression tag	UNP O94826
B	614	VAL	-	expression tag	UNP O94826
B	615	LEU	-	expression tag	UNP O94826
B	616	PHE	-	expression tag	UNP O94826
B	617	GLN	-	expression tag	UNP O94826

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	117	Total	O	0	0
			117	117		

Continued on next page...

Continued from previous page...

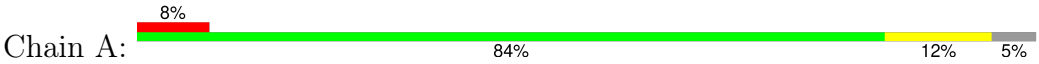
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	B	111	Total O 111 111	0	0

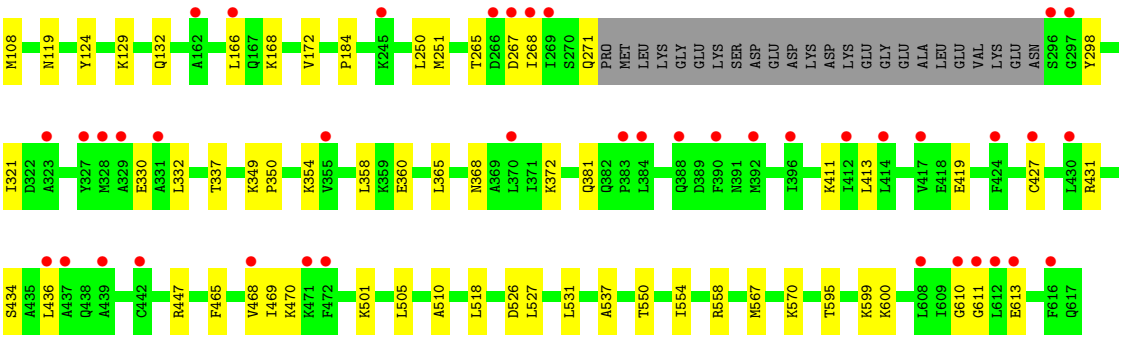
3 Residue-property plots (i)

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: Mitochondrial import receptor subunit TOM70

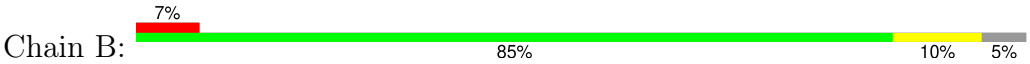
Chain A:

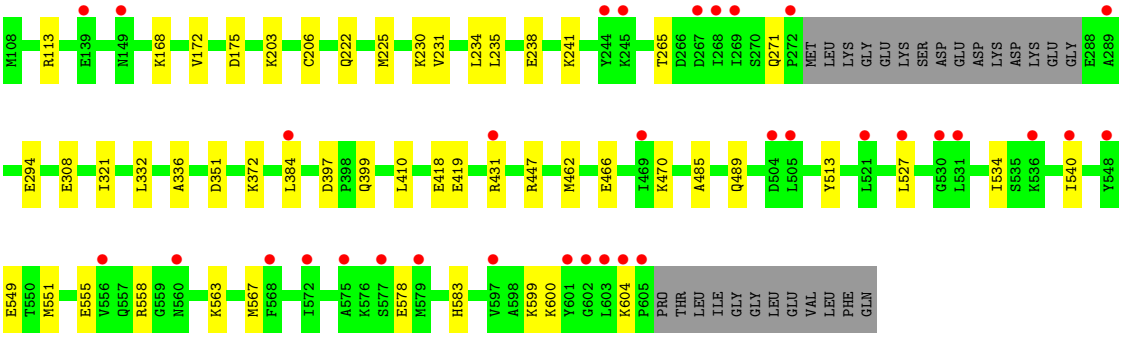




• Molecule 1: Mitochondrial import receptor subunit TOM70

Chain B:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	65.45Å 89.36Å 105.78Å 90.00° 104.86° 90.00°	Depositor
Resolution (Å)	102.24 – 2.00 102.24 – 2.00	Depositor EDS
% Data completeness (in resolution range)	97.4 (102.24-2.00) 97.4 (102.24-2.00)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.17 (at 2.00Å)	Xtriage
Refinement program	PHENIX 1.21.1_5286	Depositor
R, R_{free}	0.228 , 0.260 0.228 , 0.260	Depositor DCC
R_{free} test set	3781 reflections (4.75%)	wwPDB-VP
Wilson B-factor (Å^2)	53.9	Xtriage
Anisotropy	0.135	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 41.5	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	15702	wwPDB-VP
Average B, all atoms (Å^2)	75.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.47% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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	0.33	0/3941	0.53	0/5295
1	B	0.33	0/3935	0.51	0/5287
All	All	0.33	0/7876	0.52	0/10582

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

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	3876	3877	3877	55	0
1	B	3868	3853	3852	40	0
2	A	117	0	0	21	0
2	B	111	0	0	11	0
All	All	7972	7730	7729	95	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 (95) 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:A:427:CYS:SG	2:A:709:HOH:O	2.03	1.12

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:124:TYR:OH	2:A:701:HOH:O	1.79	0.98
1:A:119:ASN:O	2:A:702:HOH:O	1.92	0.88
1:B:222:GLN:NE2	2:B:703:HOH:O	2.06	0.88
1:A:613:GLU:OE2	2:A:703:HOH:O	1.93	0.84
1:A:469:ILE:HG22	1:A:470:LYS:HE2	1.60	0.83
1:A:166:LEU:O	2:A:704:HOH:O	1.96	0.82
1:B:384:LEU:HD12	1:B:384:LEU:H	1.44	0.81
1:A:265:THR:O	1:A:271:GLN:NE2	2.15	0.80
1:A:470:LYS:NZ	2:A:708:HOH:O	2.07	0.80
1:B:431:ARG:NH2	2:B:701:HOH:O	1.92	0.79
1:A:567:MET:HA	1:A:567:MET:HE2	1.64	0.79
1:A:611:GLY:O	2:A:705:HOH:O	2.01	0.78
1:A:526:ASP:OD2	2:A:706:HOH:O	2.03	0.75
1:A:610:GLY:O	2:A:707:HOH:O	2.04	0.75
1:B:555:GLU:OE1	1:B:558:ARG:NH2	2.21	0.72
1:B:175:ASP:OD1	2:B:704:HOH:O	2.07	0.72
1:A:354:LYS:O	1:A:358:LEU:HD12	1.91	0.70
1:B:397:ASP:OD1	2:B:706:HOH:O	2.10	0.70
1:B:308:GLU:OE2	2:B:705:HOH:O	2.09	0.70
1:B:265:THR:O	1:B:271:GLN:NE2	2.26	0.68
1:B:600:LYS:NZ	2:B:709:HOH:O	2.25	0.68
1:A:372:LYS:NZ	2:A:710:HOH:O	2.18	0.68
1:A:419:GLU:OE1	1:A:419:GLU:N	2.25	0.68
1:A:531:LEU:HD21	1:A:554:ILE:HG21	1.77	0.67
1:A:600:LYS:NZ	2:A:714:HOH:O	2.27	0.67
1:B:551:MET:HB2	1:B:567:MET:HE3	1.77	0.66
1:B:551:MET:CB	1:B:567:MET:HE3	2.26	0.66
1:B:294:GLU:OE2	2:B:707:HOH:O	2.13	0.66
1:A:501:LYS:O	1:A:505:LEU:HD13	1.96	0.65
1:B:168:LYS:O	1:B:172:VAL:HG23	1.98	0.64
1:A:360:GLU:N	1:A:360:GLU:OE2	2.30	0.64
1:B:527:LEU:HD21	1:B:558:ARG:HD3	1.80	0.63
1:B:599:LYS:HD2	1:B:600:LYS:N	2.14	0.63
1:B:372:LYS:NZ	2:B:702:HOH:O	2.05	0.62
1:A:124:TYR:CZ	2:A:701:HOH:O	2.48	0.62
1:B:230:LYS:O	1:B:234:LEU:HD13	2.00	0.62
1:A:337:THR:OG1	1:A:372:LYS:HE3	2.01	0.60
1:B:462:MET:HE1	1:B:485:ALA:HB1	1.83	0.59
1:A:595:THR:HG22	1:A:599:LYS:HE3	1.84	0.58
1:A:184:PRO:HA	2:A:732:HOH:O	2.04	0.57
1:A:434:SER:CB	2:A:709:HOH:O	2.52	0.57

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:168:LYS:CG	2:A:704:HOH:O	2.52	0.56
1:B:418:GLU:H	1:B:418:GLU:CD	2.14	0.55
1:B:231:VAL:O	1:B:235:LEU:HD23	2.05	0.55
1:A:108:MET:N	2:A:720:HOH:O	2.40	0.53
1:A:527:LEU:HD21	1:A:558:ARG:HD3	1.90	0.53
1:B:447:ARG:NH1	2:B:718:HOH:O	2.38	0.52
1:B:206:CYS:SG	1:B:231:VAL:HG21	2.50	0.51
1:A:168:LYS:O	1:A:172:VAL:HG23	2.11	0.51
1:B:113:ARG:NH1	2:B:714:HOH:O	2.35	0.50
1:B:555:GLU:CD	1:B:563:LYS:HD2	2.37	0.50
1:A:268:ILE:HD12	1:A:365:LEU:CD2	2.42	0.50
1:B:534:ILE:HG21	1:B:551:MET:HG2	1.93	0.49
1:B:431:ARG:O	1:B:431:ARG:HG3	2.12	0.49
1:B:336:ALA:HB2	1:B:351:ASP:HB2	1.94	0.49
1:A:411:LYS:HD3	1:A:419:GLU:HB2	1.95	0.49
1:A:469:ILE:HG22	1:A:470:LYS:CE	2.38	0.48
1:A:168:LYS:HG3	2:A:704:HOH:O	2.10	0.48
1:A:595:THR:CG2	1:A:599:LYS:HE3	2.43	0.48
1:A:368:ASN:OD1	1:A:372:LYS:HE2	2.14	0.47
1:A:268:ILE:HD12	1:A:365:LEU:HD23	1.96	0.47
1:A:330:GLU:HG3	1:A:365:LEU:HD11	1.97	0.47
1:A:381:GLN:N	1:A:381:GLN:OE1	2.48	0.47
1:B:549:GLU:OE2	1:B:583:HIS:NE2	2.48	0.46
1:A:465:PHE:O	1:A:468:VAL:HG12	2.15	0.46
1:A:431:ARG:NH2	2:A:717:HOH:O	2.36	0.46
1:A:267:ASP:O	1:A:271:GLN:CD	2.59	0.45
1:A:431:ARG:HB2	2:A:765:HOH:O	2.16	0.45
1:A:518:LEU:HD21	1:A:550:THR:HG23	1.99	0.45
1:B:466:GLU:O	1:B:470:LYS:HE2	2.17	0.45
1:A:298:TYR:CE2	1:A:330:GLU:HB3	2.52	0.45
1:B:203:LYS:NZ	1:B:238:GLU:OE2	2.39	0.44
1:A:168:LYS:HG2	2:A:704:HOH:O	2.15	0.43
1:A:349:LYS:N	1:A:350:PRO:HD2	2.33	0.43
1:A:436:LEU:HD22	1:A:436:LEU:N	2.33	0.43
1:A:250:LEU:HD23	1:A:251:MET:O	2.19	0.43
1:B:462:MET:HE3	1:B:489:GLN:HG3	2.02	0.42
1:A:567:MET:CE	1:A:570:LYS:HD2	2.50	0.42
1:A:567:MET:HE2	1:A:570:LYS:HD2	2.01	0.41
1:B:399:GLN:HB2	2:B:706:HOH:O	2.19	0.41
1:B:410:LEU:HD12	1:B:410:LEU:O	2.21	0.41
1:A:413:LEU:CD1	2:A:716:HOH:O	2.67	0.41

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:468:VAL:CG1	1:A:469:ILE:N	2.84	0.41
1:B:234:LEU:CD1	1:B:234:LEU:N	2.83	0.41
1:A:267:ASP:O	1:A:271:GLN:HG2	2.21	0.41
1:A:129:LYS:HD2	1:A:132:GLN:OE1	2.21	0.41
1:A:510:ALA:HB1	1:A:537:ALA:HB1	2.03	0.41
1:B:513:TYR:CE2	1:B:540:ILE:HD13	2.55	0.41
1:B:225:MET:HE3	1:B:225:MET:HB3	1.94	0.41
1:A:321:ILE:HD11	1:A:332:LEU:HA	2.02	0.40
1:B:321:ILE:HD11	1:B:332:LEU:HA	2.03	0.40
1:B:241:LYS:HA	1:B:578:GLU:OE1	2.21	0.40
1:B:419:GLU:H	1:B:419:GLU:CD	2.26	0.40
1:B:599:LYS:HD2	1:B:599:LYS:C	2.46	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	483/510 (95%)	475 (98%)	8 (2%)	0	100	100
1	B	482/510 (94%)	474 (98%)	8 (2%)	0	100	100
All	All	965/1020 (95%)	949 (98%)	16 (2%)	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	411/431 (95%)	409 (100%)	2 (0%)	86 90
1	B	411/431 (95%)	410 (100%)	1 (0%)	92 94
All	All	822/862 (95%)	819 (100%)	3 (0%)	92 92

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	447[A]	ARG
1	A	447[B]	ARG
1	B	604	LYS

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

Mol	Chain	Res	Type
1	A	165	GLN
1	A	202	ASN
1	A	246	ASN
1	A	271	GLN
1	A	400	ASN
1	A	409	GLN
1	A	484	GLN
1	B	135	GLN
1	B	165	GLN
1	B	295	ASN
1	B	303	GLN
1	B	309	ASN
1	B	388	GLN
1	B	489	GLN
1	B	520	GLN

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 (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, 95^{th} 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	486/510 (95%)	0.62	41 (8%)	18	17	36, 70, 109, 122	1 (0%)
1	B	483/510 (94%)	0.62	34 (7%)	24	22	46, 70, 109, 138	3 (0%)
All	All	969/1020 (95%)	0.62	75 (7%)	21	19	36, 70, 109, 138	4 (0%)

All (75) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	605	PRO	3.7
1	B	603	LEU	3.7
1	A	616	PHE	3.6
1	B	244	TYR	3.5
1	A	611	GLY	3.5
1	A	608	LEU	3.4
1	B	504[A]	ASP	3.3
1	B	245	LYS	3.2
1	B	601	TYR	3.2
1	B	267	ASP	3.1
1	A	166	LEU	3.1
1	B	272	PRO	3.0
1	A	427	CYS	2.9
1	A	162	ALA	2.9
1	A	439	ALA	2.9
1	B	548	TYR	2.9
1	B	597	VAL	2.9
1	B	527	LEU	2.9
1	B	469	ILE	2.9
1	A	436	LEU	2.8
1	B	431	ARG	2.8
1	A	424	PHE	2.7
1	A	245	LYS	2.7
1	B	139[A]	GLU	2.7

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	B	530	GLY	2.7
1	A	268	ILE	2.7
1	B	540	ILE	2.7
1	B	531	LEU	2.7
1	A	437	ALA	2.6
1	A	468	VAL	2.6
1	B	602	GLY	2.6
1	A	296	SER	2.5
1	A	383	PRO	2.5
1	B	577	SER	2.5
1	A	612	LEU	2.5
1	A	267	ASP	2.5
1	B	268	ILE	2.4
1	A	384	LEU	2.4
1	A	442	CYS	2.4
1	A	329	ALA	2.4
1	A	266	ASP	2.4
1	A	613	GLU	2.3
1	B	575	ALA	2.3
1	A	414	LEU	2.3
1	B	560	ASN	2.3
1	B	556	VAL	2.3
1	A	610	GLY	2.3
1	A	471	LYS	2.3
1	B	149[A]	ASN	2.3
1	B	604	LYS	2.3
1	A	328	MET	2.3
1	A	472	PHE	2.2
1	B	572	ILE	2.2
1	A	327	TYR	2.2
1	A	430	LEU	2.2
1	A	323	ALA	2.2
1	B	536	LYS	2.2
1	A	388	GLN	2.2
1	A	370	LEU	2.2
1	B	384	LEU	2.2
1	B	289	ALA	2.2
1	A	355	VAL	2.2
1	A	417	VAL	2.2
1	A	392	MET	2.2
1	A	390	PHE	2.1
1	A	331	ALA	2.1

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	A	297	GLY	2.1
1	B	505	LEU	2.1
1	A	396	ILE	2.1
1	A	269	ILE	2.1
1	B	568	PHE	2.1
1	B	521	LEU	2.0
1	A	412	ILE	2.0
1	B	269	ILE	2.0
1	B	579	MET	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.