Full wwPDB X-ray Structure Validation Report ⓘ

Nov 6, 2023 – 02:53 PM EST

PDB ID	:	4ZF4
Title	:	Crystal structure of Green Fluorescent Protein (GFP); S65T, Y66(Cl1Y), H148D; circular permutant (50-51)
Authors	:	Oltrogge, L.M.; Boxer, S.G.
Deposited on	:	2015-04-21
Resolution	:	1.82 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:

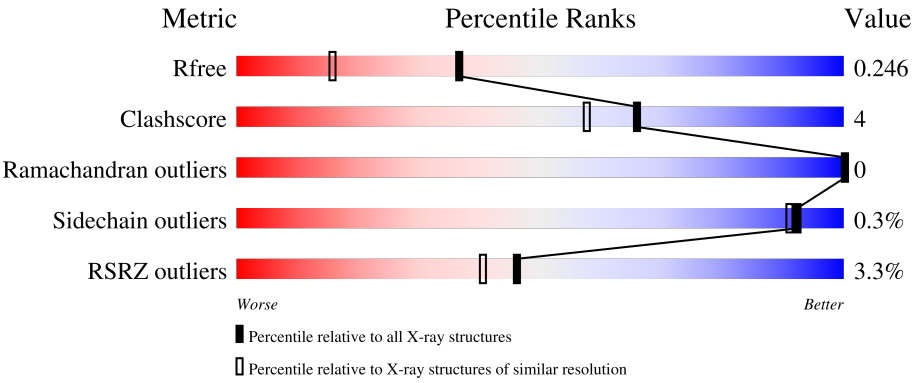
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

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 1.82 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}	130704	7484 (1.84-1.80)
Clashscore	141614	8401 (1.84-1.80)
Ramachandran outliers	138981	8290 (1.84-1.80)
Sidechain outliers	138945	8290 (1.84-1.80)
RSRZ outliers	127900	7371 (1.84-1.80)

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	252	2% 82% 8% 10%
1	B	252	4% 80% 9% 11%

2 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 3680 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 Green fluorescent protein.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	227	Total	C	Cl	N	O	S	0	0	0
			1798	1139	1	307	347	4			
1	B	224	Total	C	Cl	N	O	S	0	0	0
			1783	1131	1	303	344	4			

There are 82 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-10	MET	-	initiating methionine	UNP P42212
A	-9	GLY	-	expression tag	UNP P42212
A	-8	HIS	-	expression tag	UNP P42212
A	-7	HIS	-	expression tag	UNP P42212
A	-6	HIS	-	expression tag	UNP P42212
A	-5	HIS	-	expression tag	UNP P42212
A	-4	HIS	-	expression tag	UNP P42212
A	-3	HIS	-	expression tag	UNP P42212
A	-2	SER	-	expression tag	UNP P42212
A	-1	SER	-	expression tag	UNP P42212
A	0	GLY	-	expression tag	UNP P42212
A	14	LEU	PHE	engineered mutation	UNP P42212
A	15	4NT	SER	chromophore	UNP P42212
A	?	4NT	TYR	chromophore	UNP P42212
A	?	4NT	GLY	chromophore	UNP P42212
A	30	ARG	GLN	engineered mutation	UNP P42212
A	49	SER	PHE	engineered mutation	UNP P42212
A	55	LYS	ASN	engineered mutation	UNP P42212
A	61	VAL	GLU	engineered mutation	UNP P42212
A	78	THR	ILE	engineered mutation	UNP P42212
A	95	PHE	TYR	engineered mutation	UNP P42212
A	98	ASP	HIS	engineered mutation	UNP P42212
A	103	THR	MET	engineered mutation	UNP P42212
A	113	ALA	VAL	engineered mutation	UNP P42212
A	116	THR	LYS	engineered mutation	UNP P42212

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Chain	Residue	Modelled	Actual	Comment	Reference
A	117	VAL	ILE	engineered mutation	UNP P42212
A	121	VAL	ILE	engineered mutation	UNP P42212
A	155	THR	SER	engineered mutation	UNP P42212
A	156	VAL	ALA	engineered mutation	UNP P42212
A	188	GLY	-	linker	UNP P42212
A	189	GLY	-	linker	UNP P42212
A	190	THR	-	linker	UNP P42212
A	191	GLY	-	linker	UNP P42212
A	192	GLY	-	linker	UNP P42212
A	193	SER	-	linker	UNP P42212
A	194	ALA	-	linker	UNP P42212
A	195	SER	-	linker	UNP P42212
A	196	GLN	-	linker	UNP P42212
A	223	ARG	SER	engineered mutation	UNP P42212
A	232	ILE	TYR	engineered mutation	UNP P42212
A	241	SER	CYS	engineered mutation	UNP P42212
B	-10	MET	-	initiating methionine	UNP P42212
B	-9	GLY	-	expression tag	UNP P42212
B	-8	HIS	-	expression tag	UNP P42212
B	-7	HIS	-	expression tag	UNP P42212
B	-6	HIS	-	expression tag	UNP P42212
B	-5	HIS	-	expression tag	UNP P42212
B	-4	HIS	-	expression tag	UNP P42212
B	-3	HIS	-	expression tag	UNP P42212
B	-2	SER	-	expression tag	UNP P42212
B	-1	SER	-	expression tag	UNP P42212
B	0	GLY	-	expression tag	UNP P42212
B	14	LEU	PHE	engineered mutation	UNP P42212
B	15	4NT	SER	chromophore	UNP P42212
B	?	4NT	TYR	chromophore	UNP P42212
B	?	4NT	GLY	chromophore	UNP P42212
B	30	ARG	GLN	engineered mutation	UNP P42212
B	49	SER	PHE	engineered mutation	UNP P42212
B	55	LYS	ASN	engineered mutation	UNP P42212
B	61	VAL	GLU	engineered mutation	UNP P42212
B	78	THR	ILE	engineered mutation	UNP P42212
B	95	PHE	TYR	engineered mutation	UNP P42212
B	98	ASP	HIS	engineered mutation	UNP P42212
B	103	THR	MET	engineered mutation	UNP P42212
B	113	ALA	VAL	engineered mutation	UNP P42212
B	116	THR	LYS	engineered mutation	UNP P42212
B	117	VAL	ILE	engineered mutation	UNP P42212

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Chain	Residue	Modelled	Actual	Comment	Reference
B	121	VAL	ILE	engineered mutation	UNP P42212
B	155	THR	SER	engineered mutation	UNP P42212
B	156	VAL	ALA	engineered mutation	UNP P42212
B	188	GLY	-	linker	UNP P42212
B	189	GLY	-	linker	UNP P42212
B	190	THR	-	linker	UNP P42212
B	191	GLY	-	linker	UNP P42212
B	192	GLY	-	linker	UNP P42212
B	193	SER	-	linker	UNP P42212
B	194	ALA	-	linker	UNP P42212
B	195	SER	-	linker	UNP P42212
B	196	GLN	-	linker	UNP P42212
B	223	ARG	SER	engineered mutation	UNP P42212
B	232	ILE	TYR	engineered mutation	UNP P42212
B	241	SER	CYS	engineered mutation	UNP P42212

- Molecule 2 is water.

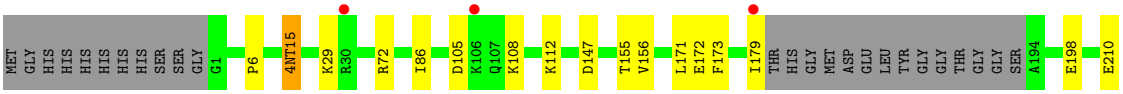
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	58	Total O 58 58	0	0
2	B	41	Total O 41 41	0	0

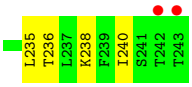
3 Residue-property plots (i)

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: Green fluorescent protein

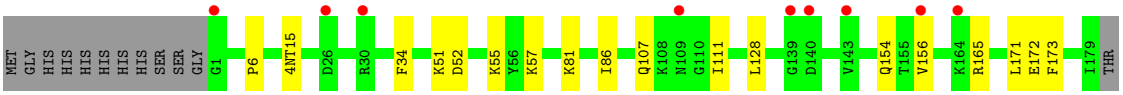
Chain A:

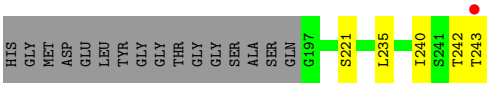




• Molecule 1: Green fluorescent protein

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	51.84Å 68.59Å 60.88Å 90.00° 100.50° 90.00°	Depositor
Resolution (Å)	36.34 – 1.82 36.34 – 1.82	Depositor EDS
% Data completeness (in resolution range)	98.6 (36.34-1.82) 98.6 (36.34-1.82)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.12 (at 1.82Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.9_1692)	Depositor
R, R_{free}	0.198 , 0.246 0.202 , 0.246	Depositor DCC
R_{free} test set	1846 reflections (4.98%)	wwPDB-VP
Wilson B-factor (Å^2)	19.6	Xtriage
Anisotropy	0.590	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.38 , 40.1	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	3680	wwPDB-VP
Average B, all atoms (Å^2)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.06% 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

Bond lengths and bond angles in the following residue types are not validated in this section: 4NT

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	0.37	0/1811	0.55	0/2447
1	B	0.35	0/1796	0.54	0/2426
All	All	0.36	0/3607	0.54	0/4873

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	1798	0	1753	17	0
1	B	1783	0	1741	16	0
2	A	58	0	0	0	0
2	B	41	0	0	0	0
All	All	3680	0	3494	28	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 (28) 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:72:ARG:NH1	1:A:210:GLU:OE1	2.06	0.88
1:A:105:ASP:OD2	1:A:112:LYS:NZ	2.18	0.76
1:A:29:LYS:NZ	1:A:198:GLU:OE2	2.21	0.74
1:B:55:LYS:HE3	1:B:57:LYS:HE3	1.71	0.72
1:A:108:LYS:HE3	1:A:112:LYS:HZ1	1.54	0.72
1:B:165:ARG:HE	1:B:240:ILE:HG21	1.54	0.71
1:A:171:LEU:HD22	1:B:171:LEU:HD22	1.76	0.67
1:A:173:PHE:CD1	1:B:156:VAL:HG11	2.32	0.65
1:B:51:LYS:HE2	1:B:128:LEU:H	1.64	0.63
1:A:108:LYS:HE3	1:A:112:LYS:NZ	2.16	0.61
1:A:156:VAL:HG23	1:B:156:VAL:HG23	1.82	0.60
1:A:156:VAL:HG11	1:B:173:PHE:CD1	2.38	0.59
1:A:171:LEU:HD12	1:A:236:THR:HG22	1.88	0.56
1:B:172:GLU:HB3	1:B:235:LEU:HB2	1.93	0.51
1:A:15:4NT:CL1	1:A:155:THR:OG1	2.68	0.47
1:B:221:SER:HB3	1:B:242:THR:OG1	2.16	0.46
1:B:107:GLN:H	1:B:107:GLN:CD	2.19	0.46
1:B:52:ASP:O	1:B:81:LYS:HE2	2.16	0.46
1:A:238:LYS:HE2	1:A:240:ILE:HD11	1.97	0.46
1:A:172:GLU:HB3	1:A:235:LEU:HB2	1.98	0.45
1:B:171:LEU:HD21	1:B:173:PHE:HE1	1.82	0.45
1:B:171:LEU:HD21	1:B:173:PHE:CE1	2.53	0.44
1:A:72:ARG:NH1	1:A:210:GLU:CD	2.71	0.44
1:A:156:VAL:HG22	1:B:154:GLN:HB3	2.00	0.44
1:B:34:PHE:CE1	1:B:111:ILE:HD11	2.53	0.44
1:A:147:ASP:HB2	1:A:179:ILE:HD11	2.01	0.42
1:A:6:PRO:HD3	1:A:86:ILE:O	2.21	0.41
1:B:6:PRO:HD3	1:B:86:ILE:O	2.19	0.41

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	220/252 (87%)	218 (99%)	2 (1%)	0	100	100
1	B	217/252 (86%)	216 (100%)	1 (0%)	0	100	100
All	All	437/504 (87%)	434 (99%)	3 (1%)	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	195/215 (91%)	195 (100%)	0	100	100
1	B	194/215 (90%)	193 (100%)	1 (0%)	88	87
All	All	389/430 (90%)	388 (100%)	1 (0%)	92	91

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	243	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA (i)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

2 non-standard protein/DNA/RNA residues are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
1	4NT	A	15	1	24,24,25	3.59	8 (33%)	32,34,36	1.70	8 (25%)
1	4NT	B	15	1	24,24,25	3.39	8 (33%)	32,34,36	1.81	9 (28%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
1	4NT	A	15	1	-	0/12/31/32	0/2/2/2
1	4NT	B	15	1	-	0/12/31/32	0/2/2/2

All (16) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	15	4NT	CZ-CE1	11.25	1.50	1.39
1	B	15	4NT	CZ-CE1	10.45	1.49	1.39
1	B	15	4NT	CD1-CG2	6.10	1.50	1.39
1	A	15	4NT	CD1-CG2	5.90	1.49	1.39
1	A	15	4NT	CE2-CZ	5.79	1.49	1.39
1	A	15	4NT	CB2-CA2	5.50	1.39	1.35
1	A	15	4NT	OH-CZ	-5.21	1.25	1.36
1	B	15	4NT	CE2-CZ	5.15	1.48	1.39
1	B	15	4NT	OH-CZ	-5.14	1.25	1.36
1	A	15	4NT	CD2-CG2	4.78	1.48	1.39
1	B	15	4NT	C1-N3	4.57	1.44	1.37
1	B	15	4NT	CD2-CG2	4.39	1.48	1.39
1	B	15	4NT	CB2-CA2	4.14	1.38	1.35
1	A	15	4NT	C1-N3	3.97	1.43	1.37
1	B	15	4NT	CG2-CB2	-2.49	1.42	1.46
1	A	15	4NT	CG2-CB2	-2.17	1.42	1.46

All (17) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	15	4NT	C2-N3-C1	-4.63	105.62	107.97
1	A	15	4NT	C2-N3-C1	-4.54	105.67	107.97
1	B	15	4NT	CA1-C1-N3	-3.24	120.86	124.75

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	15	4NT	C1-CA1-N1	-3.01	105.09	109.96
1	B	15	4NT	N3-C1-N2	2.78	113.38	111.45
1	B	15	4NT	CE2-CZ-CE1	-2.76	115.88	118.55
1	B	15	4NT	CD1-CE1-CZ	2.46	122.34	120.91
1	A	15	4NT	N3-C1-N2	2.45	113.15	111.45
1	A	15	4NT	CA2-N2-C1	2.37	107.52	105.77
1	B	15	4NT	C2-CA2-N2	2.34	110.57	108.93
1	A	15	4NT	CE2-CZ-CE1	-2.31	116.31	118.55
1	A	15	4NT	CD1-CE1-CZ	2.28	122.24	120.91
1	B	15	4NT	C1-CA1-N1	-2.26	106.29	109.96
1	B	15	4NT	CB2-CA2-C2	-2.25	119.59	122.28
1	A	15	4NT	CA1-C1-N3	-2.23	122.08	124.75
1	A	15	4NT	CG2-CB2-CA2	2.17	132.60	129.94
1	B	15	4NT	CD1-CE1-CL1	2.06	121.82	118.49

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	A	15	4NT	1	0

5.5 Carbohydrates (i)

There are no monosaccharides 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	226/252 (89%)	0.29	5 (2%) 62 58	13, 20, 32, 40	0
1	B	223/252 (88%)	0.46	10 (4%) 33 27	15, 24, 36, 52	0
All	All	449/504 (89%)	0.37	15 (3%) 46 40	13, 21, 35, 52	0

All (15) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	1	GLY	6.2
1	A	179	ILE	4.5
1	B	30	ARG	3.5
1	A	30	ARG	3.3
1	A	243	THR	3.2
1	B	243	THR	3.2
1	B	26	ASP	2.8
1	B	109	ASN	2.4
1	B	156	VAL	2.4
1	B	139	GLY	2.4
1	B	164	LYS	2.4
1	B	140	ASP	2.3
1	B	143	VAL	2.2
1	A	106	LYS	2.2
1	A	242	THR	2.1

6.2 Non-standard residues in protein, DNA, RNA chains

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
1	4NT	B	15	23/24	0.88	0.15	16,18,22,30	0
1	4NT	A	15	23/24	0.92	0.12	15,16,20,27	0

6.3 Carbohydrates (i)

There are no monosaccharides 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.