



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 28, 2026 – 08:43 PM UTC

PDB ID : 4WK8 / pdb_00004wk8
Title : FOXP3 forms a domain-swapped dimer to bridge DNA
Authors : Chen, Y.; Chen, L.
Deposited on : 2014-10-01
Resolution : 3.40 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

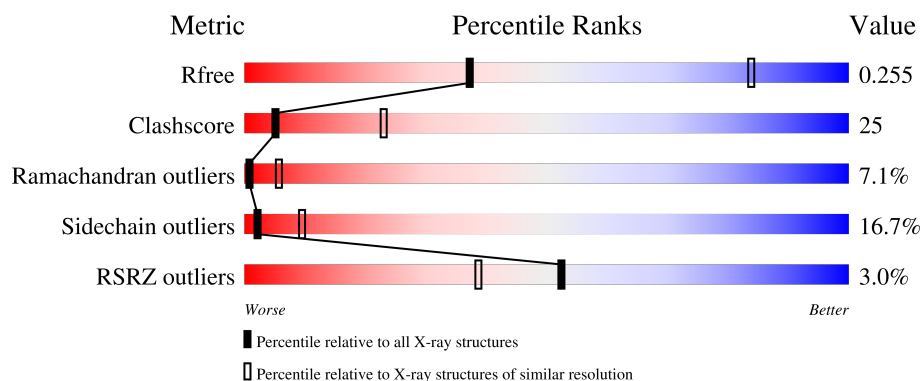
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.40 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	1001 (3.44-3.36)
Clashscore	190562	1022 (3.44-3.36)
Ramachandran outliers	187476	1012 (3.44-3.36)
Sidechain outliers	187428	1012 (3.44-3.36)
RSRZ outliers	180081	1001 (3.44-3.36)

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	21	
2	B	21	
3	F	82	
3	G	82	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2243 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 DNA chain called DNA (5'-D(*TP*TP*AP*GP*GP*AP*AP*AP*AP*TP*TP*TP*GP*TP*TP*TP*CP*AP*TP*AP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	21	Total	C	N	O	P	0	0	0
			431	209	76	126	20			

- Molecule 2 is a DNA chain called DNA (5'-D(*AP*AP*CP*TP*AP*TP*GP*AP*AP*AP*CP*AP*AP*AP*TP*TP*TP*TP*CP*CP*T)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	21	Total	C	N	O	P	0	0	0
			424	206	76	122	20			

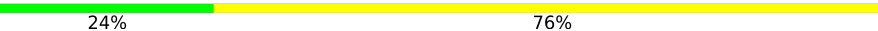
- Molecule 3 is a protein called Forkhead box protein P3.

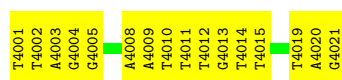
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	80	Total	C	N	O	S	0	0	0
			694	454	127	111	2			
3	G	80	Total	C	N	O	S	0	0	0
			694	454	127	111	2			

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.

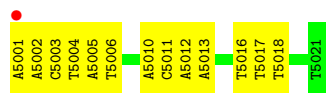
- Molecule 1: DNA (5'-D(*TP*TP*AP*GP*GP*AP*AP*AP*AP*TP*TP*TP*GP*TP*TP*TP*CP*AP*TP*AP*G)-3')

Chain A: 



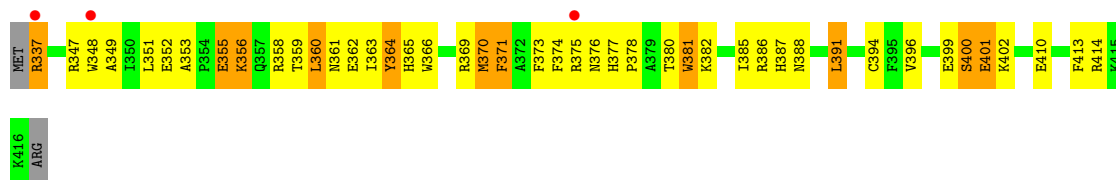
- Molecule 2: DNA (5'-D(*AP*AP*CP*TP*AP*TP*GP*AP*AP*AP*CP*AP*AP*AP*TP*TP*TP*TP*CP*CP*T)-3')

Chain B: 



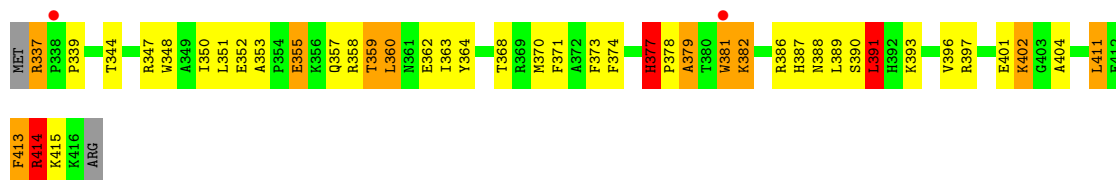
- Molecule 3: Forkhead box protein P3

Chain F: 



- Molecule 3: Forkhead box protein P3

Chain G: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α , β , γ	81.43Å 84.84Å 68.31Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	44.54 – 3.40 44.54 – 3.40	Depositor EDS
% Data completeness (in resolution range)	94.9 (44.54-3.40) 86.9 (44.54-3.40)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	0.39 (at 3.32Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.4_1496)	Depositor
R, R_{free}	0.190 , 0.253 0.193 , 0.255	Depositor DCC
R_{free} test set	666 reflections (9.48%)	wwPDB-VP
Wilson B-factor (Å ²)	54.7	Xtriage
Anisotropy	0.726	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.26 , 48.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.035 for k,h,-l	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	2243	wwPDB-VP
Average B, all atoms (Å ²)	61.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.68% 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	0.58	0/483	0.80	0/745
2	B	0.60	0/475	0.80	0/730
3	F	0.90	0/718	1.14	3/972 (0.3%)
3	G	0.83	0/718	1.09	4/972 (0.4%)
All	All	0.77	0/2394	0.99	7/3419 (0.2%)

There are no bond length outliers.

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	G	377	HIS	CA-C-N	-5.98	112.36	119.84
3	G	377	HIS	C-N-CA	-5.98	112.36	119.84
3	F	381	TRP	N-CA-C	-5.42	107.21	113.88
3	G	351	LEU	N-CA-C	5.31	117.98	111.82
3	F	364	TYR	N-CA-C	-5.07	104.83	111.02
3	G	401	GLU	N-CA-C	-5.01	107.13	113.20
3	F	371	PHE	N-CA-C	-5.00	105.11	111.11

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	431	0	242	19	0
2	B	424	0	240	15	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	F	694	0	686	42	0
3	G	694	0	686	43	0
All	All	2243	0	1854	99	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 25.

All (99) 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)
3:F:355:GLU:N	3:F:355:GLU:OE2	2.19	0.74
1:A:4002:DT:H2''	1:A:4003:DA:H5''	1.69	0.74
1:A:4021:DG:H1	2:B:5003:DC:N4	1.88	0.72
3:G:355:GLU:H	3:G:355:GLU:CD	1.97	0.72
3:F:359:THR:O	3:F:362:GLU:N	2.29	0.65
1:A:4021:DG:N2	2:B:5003:DC:N3	2.45	0.64
3:F:413:PHE:CE2	3:G:347:ARG:HD2	2.33	0.64
1:A:4011:DT:H2''	1:A:4012:DT:H5''	1.82	0.61
3:F:399:GLU:H	3:F:399:GLU:CD	2.07	0.61
2:B:5003:DC:H2''	2:B:5004:DT:OP2	2.01	0.60
1:A:4003:DA:C8	1:A:4003:DA:H5'	2.37	0.60
1:A:4021:DG:H1	2:B:5003:DC:H42	1.49	0.60
3:G:413:PHE:CG	3:G:414:ARG:N	2.69	0.58
3:F:381:TRP:O	3:F:385:ILE:HD12	2.04	0.57
3:G:359:THR:HG23	3:G:362:GLU:OE2	2.05	0.57
3:F:364:TYR:CZ	3:G:382:LYS:HG2	2.40	0.56
1:A:4002:DT:C2'	1:A:4003:DA:H5''	2.35	0.56
2:B:5018:DT:H6	2:B:5018:DT:H5'	1.69	0.56
3:G:352:GLU:HB3	3:G:358:ARG:NH2	2.19	0.56
3:G:358:ARG:HD2	3:G:362:GLU:HB3	1.87	0.56
3:F:387:HIS:CE1	3:F:391:LEU:HG	2.41	0.56
3:F:337:ARG:HB3	3:F:337:ARG:NH1	2.22	0.55
2:B:5018:DT:H5'	2:B:5018:DT:C6	2.41	0.55
3:F:352:GLU:CD	3:G:348:TRP:HE1	2.13	0.55
3:F:374:PHE:HD2	3:G:371:PHE:CD2	2.25	0.54
3:F:399:GLU:N	3:F:399:GLU:OE2	2.40	0.54
3:G:377:HIS:C	3:G:379:ALA:H	2.14	0.54
3:F:349:ALA:HB2	3:F:366:TRP:CD2	2.43	0.54
1:A:4014:DT:H1'	1:A:4015:DT:H5'	1.90	0.54
3:F:388:ASN:H	3:F:388:ASN:HD22	1.56	0.54
3:F:410:GLU:O	3:F:414:ARG:HG3	2.09	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:F:364:TYR:HB3	3:G:381:TRP:HZ3	1.74	0.52
3:G:355:GLU:O	3:G:357:GLN:HG2	2.10	0.52
3:F:359:THR:O	3:F:361:ASN:N	2.43	0.52
2:B:5012:DA:H1'	2:B:5013:DA:H5'	1.92	0.51
3:F:353:ALA:HB2	3:F:358:ARG:HG2	1.91	0.51
3:G:413:PHE:O	3:G:415:LYS:N	2.43	0.51
3:F:352:GLU:HG3	3:G:348:TRP:CZ2	2.46	0.51
3:F:371:PHE:CD1	3:G:374:PHE:HD2	2.28	0.51
2:B:5005:DA:H2'	2:B:5006:DT:H71	1.93	0.50
2:B:5016:DT:C6	2:B:5017:DT:H72	2.46	0.50
2:B:5001:DA:C2	2:B:5002:DA:C6	3.00	0.50
3:F:348:TRP:CH2	3:G:352:GLU:HA	2.47	0.50
3:F:370:MET:HG2	3:G:374:PHE:CZ	2.47	0.49
2:B:5004:DT:H2''	2:B:5005:DA:O5'	2.12	0.49
3:G:397:ARG:HH11	3:G:404:ALA:HB1	1.78	0.49
3:G:360:LEU:HD13	3:G:364:TYR:CE2	2.47	0.49
3:G:397:ARG:NH1	3:G:404:ALA:HB1	2.28	0.49
3:G:411:LEU:O	3:G:414:ARG:NH2	2.46	0.48
1:A:4008:DA:H2''	1:A:4009:DA:H5''	1.94	0.48
2:B:5004:DT:H3'	2:B:5004:DT:P	2.54	0.48
3:G:381:TRP:CG	3:G:382:LYS:H	2.32	0.48
1:A:4001:DT:H2'	1:A:4001:DT:O2	2.13	0.48
1:A:4019:DT:H2'	1:A:4020:DA:C8	2.49	0.48
3:G:353:ALA:HB2	3:G:358:ARG:NE	2.28	0.48
3:F:364:TYR:HB3	3:G:381:TRP:CZ3	2.49	0.47
3:F:370:MET:HB2	3:F:370:MET:HE2	1.58	0.47
3:F:399:GLU:CD	3:F:399:GLU:N	2.71	0.47
1:A:4020:DA:H2''	1:A:4021:DG:OP2	2.14	0.47
3:G:388:ASN:O	3:G:389:LEU:C	2.59	0.46
2:B:5002:DA:C8	2:B:5002:DA:OP1	2.69	0.46
2:B:5002:DA:H8	2:B:5002:DA:H5''	1.81	0.46
3:F:377:HIS:CD2	3:F:378:PRO:O	2.69	0.46
3:F:363:ILE:O	3:F:364:TYR:C	2.59	0.46
3:F:351:LEU:HD23	3:F:356:LYS:HG3	1.98	0.46
1:A:4013:DG:H2''	1:A:4014:DT:H5'	1.97	0.46
3:F:359:THR:O	3:F:360:LEU:C	2.58	0.45
3:F:351:LEU:HD23	3:F:351:LEU:HA	1.66	0.45
1:A:4002:DT:H2'	1:A:4002:DT:OP2	2.17	0.45
3:F:347:ARG:NH2	3:G:413:PHE:CG	2.85	0.45
1:A:4009:DA:H1'	1:A:4010:DT:H5'	1.98	0.45
3:F:401:GLU:HB3	3:F:402:LYS:H	1.52	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:F:337:ARG:HB3	3:F:337:ARG:HH11	1.81	0.45
1:A:4003:DA:H5'	1:A:4003:DA:H8	1.80	0.45
3:F:400:SER:HB2	3:F:401:GLU:OE2	2.17	0.45
3:F:371:PHE:CE1	3:G:378:PRO:HA	2.52	0.45
3:G:355:GLU:CD	3:G:355:GLU:N	2.69	0.45
3:F:369:ARG:NH2	3:G:339:PRO:O	2.51	0.44
3:F:377:HIS:CG	3:G:371:PHE:CE2	3.06	0.44
3:F:382:LYS:HD3	3:G:364:TYR:CE1	2.52	0.44
3:F:365:HIS:O	3:F:369:ARG:HG3	2.17	0.43
3:G:402:LYS:HD2	3:G:402:LYS:HA	1.52	0.43
3:G:387:HIS:O	3:G:391:LEU:HB2	2.18	0.43
3:G:360:LEU:HD22	3:G:364:TYR:HE2	1.83	0.43
2:B:5010:DA:H1'	2:B:5011:DC:H5'	2.00	0.43
3:G:377:HIS:C	3:G:379:ALA:N	2.77	0.43
1:A:4011:DT:C2'	1:A:4012:DT:H5''	2.48	0.43
3:F:385:ILE:O	3:F:386:ARG:C	2.61	0.43
3:G:370:MET:HE2	3:G:370:MET:HB2	1.86	0.43
1:A:4001:DT:O5'	1:A:4002:DT:OP2	2.37	0.43
3:G:414:ARG:HB2	3:G:414:ARG:NH1	2.34	0.43
3:G:337:ARG:HA	3:G:337:ARG:HD2	1.73	0.42
3:G:359:THR:O	3:G:363:ILE:HG13	2.19	0.42
1:A:4004:DG:H2''	1:A:4005:DG:O5'	2.20	0.41
3:F:364:TYR:CE2	3:G:382:LYS:HG2	2.55	0.41
3:G:373:PHE:CD2	3:G:373:PHE:C	2.98	0.41
3:G:381:TRP:CD1	3:G:381:TRP:N	2.89	0.41
3:F:364:TYR:CE1	3:G:382:LYS:HG2	2.56	0.40
3:F:378:PRO:HG2	3:F:380:THR:O	2.21	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	
3	F	78/82 (95%)	69 (88%)	5 (6%)	4 (5%)	1	10
3	G	78/82 (95%)	57 (73%)	14 (18%)	7 (9%)	0	3
All	All	156/164 (95%)	126 (81%)	19 (12%)	11 (7%)	1	6

All (11) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	F	360	LEU
3	F	375	ARG
3	G	379	ALA
3	G	414	ARG
3	G	382	LYS
3	G	381	TRP
3	G	413	PHE
3	F	401	GLU
3	F	373	PHE
3	G	391	LEU
3	G	377	HIS

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	
3	F	72/74 (97%)	63 (88%)	9 (12%)	4	18
3	G	72/74 (97%)	57 (79%)	15 (21%)	1	4
All	All	144/148 (97%)	120 (83%)	24 (17%)	2	9

All (24) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	F	337	ARG
3	F	355	GLU
3	F	356	LYS
3	F	370	MET
3	F	376	ASN

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Mol	Chain	Res	Type
3	F	391	LEU
3	F	394	CYS
3	F	396	VAL
3	F	400	SER
3	G	337	ARG
3	G	344	THR
3	G	350	ILE
3	G	355	GLU
3	G	359	THR
3	G	360	LEU
3	G	368	THR
3	G	386	ARG
3	G	390	SER
3	G	391	LEU
3	G	393	LYS
3	G	396	VAL
3	G	402	LYS
3	G	411	LEU
3	G	414	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
3	F	377	HIS
3	F	387	HIS
3	F	388	ASN
3	F	392	HIS
3	G	357	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 ⓘ

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	A	21/21 (100%)	-0.52	0 100 100	27, 47, 93, 118	0
2	B	21/21 (100%)	-0.33	1 (4%) 35 26	23, 47, 120, 131	0
3	F	80/82 (97%)	0.06	3 (3%) 44 31	18, 55, 112, 160	0
3	G	80/82 (97%)	-0.07	2 (2%) 58 43	17, 53, 129, 145	0
All	All	202/206 (98%)	-0.09	6 (2%) 52 39	17, 54, 121, 160	0

All (6) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	G	338	PRO	3.5
2	B	5001	DA	2.6
3	F	348	TRP	2.5
3	F	337	ARG	2.4
3	G	381	TRP	2.4
3	F	375	ARG	2.3

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.