



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 6, 2024 – 02:00 PM EST

PDB ID : 2AZO  
Title : DNA MISMATCH REPAIR PROTEIN MUTH FROM E. COLI  
Authors : Yang, W.  
Deposited on : 1997-11-20  
Resolution : 2.30 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](mailto: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>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
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

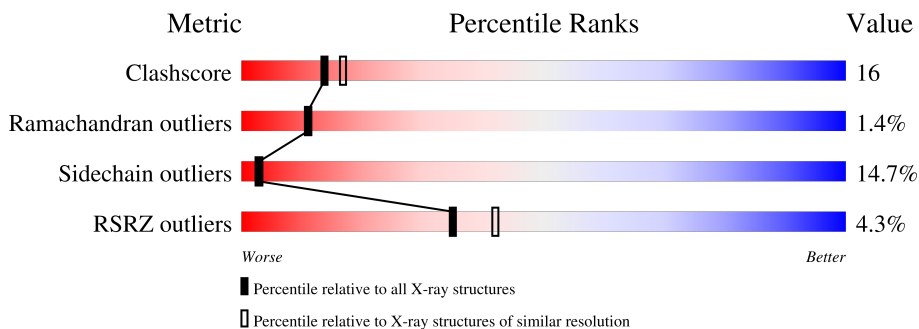
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.30 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))
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (2.30-2.30)

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  $\geq 3$ , 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	232	
1	B	232	

## 2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 3652 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 MUTH.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	218	1721	1101	306	311	3	0	0	0
1	B	227	1787	1139	318	327	3	0	0	0

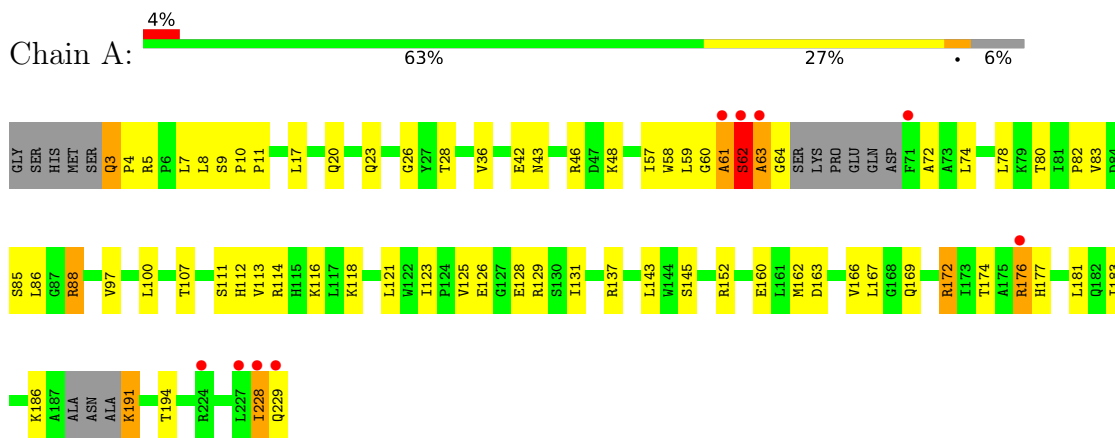
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	91	Total	O	0	0
			91	91		
2	B	53	Total	O	0	0
			53	53		

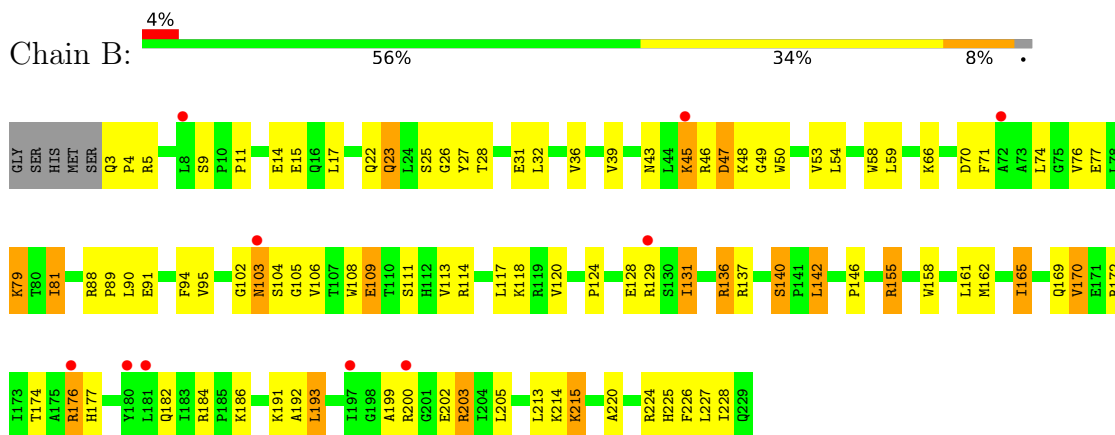
### 3 Residue-property plots [i](#)

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: MUTH



- Molecule 1: MUTH



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	39.86Å 111.57Å 54.93Å 90.00° 96.53° 90.00°	Depositor
Resolution (Å)	20.00 – 2.30 19.80 – 2.20	Depositor EDS
% Data completeness (in resolution range)	91.6 (20.00-2.30) 89.2 (19.80-2.20)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	0.08	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.26 (at 2.19Å)	Xtrriage
Refinement program	X-PLOR 3.851	Depositor
R, $R_{free}$	0.202 , 0.293 0.218 , (Not available)	Depositor DCC
$R_{free}$ test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	25.7	Xtrriage
Anisotropy	0.085	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 48.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	3652	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	29.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.09% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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	0.39	0/1756	0.64	1/2381 (0.0%)
1	B	0.35	0/1825	0.62	1/2478 (0.0%)
All	All	0.37	0/3581	0.63	2/4859 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	129	ARG	NE-CZ-NH2	7.35	123.97	120.30
1	A	62	SER	N-CA-C	-6.15	94.40	111.00

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	1721	0	1767	57	0
1	B	1787	0	1828	59	0
2	A	91	0	0	2	0
2	B	53	0	0	4	0
All	All	3652	0	3595	113	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 16.

All (113) 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:191:LYS:HG2	2:A:309:HOH:O	1.68	0.92
1:A:112:HIS:HB3	1:A:116:LYS:HE3	1.57	0.85
1:B:174:THR:HB	2:B:250:HOH:O	1.81	0.80
1:A:174:THR:HB	1:A:176:ARG:HH21	1.46	0.80
1:A:78:LEU:HD11	1:A:123:ILE:CD1	2.17	0.74
1:A:7:LEU:HB2	1:A:60:GLY:HA2	1.71	0.73
1:A:174:THR:H	1:A:177:HIS:HD2	1.37	0.70
1:B:45:LYS:HD3	2:B:276:HOH:O	1.91	0.69
1:B:17:LEU:HD12	1:B:59:LEU:HD22	1.76	0.68
1:A:26:GLY:HA2	1:B:228:ILE:HG12	1.76	0.68
1:B:28:THR:OG1	1:B:31:GLU:HG3	1.93	0.67
1:A:42:GLU:HB2	1:A:46:ARG:HH12	1.59	0.67
1:B:128:GLU:HB3	1:B:131:ILE:HG22	1.78	0.66
1:B:174:THR:HG23	1:B:176:ARG:H	1.62	0.65
1:B:199:ALA:HB3	1:B:200:ARG:NH2	2.10	0.64
1:A:28:THR:HG22	1:A:137:ARG:HG2	1.80	0.64
1:B:3:GLN:NE2	1:B:27:TYR:OH	2.32	0.62
1:A:114:ARG:HG2	1:A:114:ARG:HH11	1.65	0.62
1:A:78:LEU:HD11	1:A:123:ILE:HD12	1.80	0.62
1:A:7:LEU:HB2	1:A:60:GLY:CA	2.29	0.62
1:A:97:VAL:HG22	1:A:186:LYS:HD2	1.82	0.61
1:B:3:GLN:HB3	1:B:4:PRO:HD2	1.81	0.61
1:A:43:ASN:HB3	1:A:46:ARG:HD3	1.82	0.60
1:B:103:ASN:HB2	1:B:106:VAL:HB	1.83	0.60
1:A:10:PRO:HD3	1:A:61:ALA:CB	2.31	0.60
1:A:10:PRO:HD3	1:A:61:ALA:HB3	1.83	0.60
1:A:59:LEU:HD12	1:A:78:LEU:HD22	1.83	0.60
1:A:162:MET:O	1:A:166:VAL:HG12	2.01	0.60
1:B:3:GLN:HB2	2:B:279:HOH:O	2.01	0.60
1:B:11:PRO:HG2	1:B:17:LEU:HB2	1.82	0.60
1:B:49:GLY:O	1:B:53:VAL:HG23	2.01	0.60
1:B:70:ASP:HB2	1:B:76:VAL:O	2.02	0.59
1:A:114:ARG:HG2	1:A:114:ARG:NH1	2.18	0.58
1:A:174:THR:H	1:A:177:HIS:CD2	2.21	0.58
1:A:36:VAL:O	1:A:36:VAL:HG12	2.04	0.57
1:A:107:THR:O	1:A:111:SER:HB3	2.04	0.57
1:B:47:ASP:HB2	1:B:50:TRP:HB2	1.88	0.56
1:A:72:ALA:HB3	2:A:306:HOH:O	2.06	0.56
1:A:36:VAL:O	1:A:36:VAL:CG1	2.53	0.55
1:A:113:VAL:HG11	1:A:181:LEU:HD11	1.88	0.55
1:B:113:VAL:HG11	1:B:158:TRP:CD1	2.42	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:174:THR:HG22	1:B:177:HIS:ND1	2.21	0.54
1:B:165:ILE:HA	1:B:170:VAL:HG12	1.89	0.54
1:A:63:ALA:O	1:A:64:GLY:C	2.45	0.54
1:A:172:ARG:HA	1:A:172:ARG:HE	1.73	0.54
1:A:60:GLY:O	1:A:61:ALA:O	2.27	0.53
1:B:142:LEU:HD22	1:B:226:PHE:HE2	1.74	0.53
1:A:11:PRO:HG2	1:A:17:LEU:CD1	2.39	0.52
1:A:26:GLY:CA	1:B:228:ILE:HG12	2.40	0.52
1:B:142:LEU:HD22	1:B:226:PHE:CE2	2.45	0.51
1:A:62:SER:O	1:A:63:ALA:HB3	2.11	0.51
1:B:95:VAL:HG11	1:B:113:VAL:HG23	1.92	0.51
1:B:203:ARG:HH21	1:B:205:LEU:HD21	1.76	0.51
1:B:54:LEU:O	1:B:58:TRP:HD1	1.93	0.50
1:A:3:GLN:HA	1:A:3:GLN:HE21	1.76	0.50
1:A:163:ASP:O	1:A:167:LEU:HG	2.11	0.50
1:B:131:ILE:O	1:B:136:ARG:NH1	2.45	0.50
1:A:58:TRP:C	1:A:60:GLY:H	2.16	0.49
1:B:95:VAL:CG2	1:B:213:LEU:HG	2.42	0.49
1:B:26:GLY:O	1:B:137:ARG:HG2	2.13	0.48
1:B:94:PHE:HB3	2:B:234:HOH:O	2.13	0.48
1:B:4:PRO:HB3	1:B:23:GLN:HB3	1.96	0.48
1:B:158:TRP:O	1:B:162:MET:HB2	2.13	0.48
1:B:199:ALA:HB3	1:B:200:ARG:CZ	2.44	0.47
1:A:20:GLN:O	1:A:23:GLN:HB2	2.14	0.47
1:B:59:LEU:HD13	1:B:71:PHE:HZ	1.80	0.47
1:B:108:TRP:CD1	1:B:155:ARG:HB2	2.49	0.47
1:B:81:ILE:O	1:B:124:PRO:HA	2.14	0.47
1:B:224:ARG:HA	1:B:228:ILE:HD12	1.98	0.46
1:B:90:LEU:O	1:B:215:LYS:HE3	2.16	0.46
1:A:112:HIS:HB3	1:A:116:LYS:CE	2.38	0.46
1:B:81:ILE:HD11	1:B:89:PRO:HG3	1.97	0.46
1:A:128:GLU:HG3	1:A:131:ILE:HG13	1.98	0.45
1:B:77:GLU:HB2	1:B:120:VAL:HG22	1.98	0.45
1:A:78:LEU:HD13	1:A:121:LEU:HD23	1.98	0.45
1:B:70:ASP:HB2	1:B:77:GLU:HA	1.98	0.45
1:A:60:GLY:O	1:A:61:ALA:C	2.54	0.45
1:B:161:LEU:O	1:B:165:ILE:HD12	2.16	0.45
1:B:140:SER:HB3	1:B:226:PHE:CZ	2.52	0.45
1:A:28:THR:HA	1:A:137:ARG:HA	1.98	0.45
1:B:169:GLN:OE1	1:B:172:ARG:NH1	2.50	0.45
1:A:82:PRO:HA	1:A:125:VAL:O	2.17	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:80:THR:HG23	1:A:125:VAL:HG23	1.99	0.44
1:B:117:LEU:O	1:B:146:PRO:HD3	2.16	0.44
1:B:109:GLU:H	1:B:109:GLU:HG3	1.40	0.44
1:B:142:LEU:HD13	1:B:225:HIS:CG	2.53	0.44
1:B:220:ALA:O	1:B:224:ARG:HB2	2.18	0.44
1:B:192:ALA:O	1:B:193:LEU:HD23	2.18	0.44
1:A:11:PRO:HG2	1:A:17:LEU:HD13	2.00	0.43
1:B:111:SER:HB2	1:B:113:VAL:HG12	2.01	0.43
1:A:160:GLU:O	1:A:163:ASP:HB2	2.19	0.43
1:B:192:ALA:O	1:B:193:LEU:CD2	2.67	0.43
1:B:32:LEU:O	1:B:36:VAL:HG22	2.18	0.42
1:A:143:LEU:HD23	1:A:143:LEU:HA	1.93	0.42
1:B:182:GLN:HE21	1:B:214:LYS:HE2	1.84	0.42
1:A:86:LEU:HB2	1:A:88:ARG:HD2	2.01	0.42
1:A:100:LEU:HD12	1:A:194:THR:HG23	2.00	0.42
1:B:70:ASP:CB	1:B:77:GLU:HA	2.48	0.42
1:B:128:GLU:O	1:B:131:ILE:HG22	2.20	0.42
1:A:176:ARG:NE	1:A:176:ARG:N	2.68	0.42
1:B:79:LYS:HE2	1:B:94:PHE:O	2.20	0.42
1:A:228:ILE:HG12	1:B:22:GLN:OE1	2.20	0.42
1:B:14:GLU:HA	1:B:17:LEU:HB3	2.02	0.41
1:A:176:ARG:N	1:A:176:ARG:HE	2.18	0.41
1:A:80:THR:HG23	1:A:125:VAL:CG2	2.50	0.41
1:A:11:PRO:HB2	1:A:74:LEU:HD11	2.02	0.41
1:B:81:ILE:HD11	1:B:89:PRO:HB3	2.01	0.41
1:A:11:PRO:HG2	1:A:17:LEU:HD12	2.01	0.41
1:A:83:VAL:O	1:A:126:GLU:HA	2.21	0.41
1:A:228:ILE:HG13	1:A:229:GLN:N	2.36	0.41
1:A:42:GLU:H	1:A:46:ARG:NH2	2.20	0.40
1:B:17:LEU:CD1	1:B:59:LEU:HD22	2.50	0.40
1:A:36:VAL:HG11	1:A:57:ILE:HG21	2.02	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	A	212/232 (91%)	197 (93%)	11 (5%)	4 (2%)	8	7
1	B	225/232 (97%)	208 (92%)	15 (7%)	2 (1%)	17	20
All	All	437/464 (94%)	405 (93%)	26 (6%)	6 (1%)	11	11

All (6) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	61	ALA
1	B	102	GLY
1	B	105	GLY
1	A	63	ALA
1	A	228	ILE
1	A	4	PRO

### 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	183/194 (94%)	166 (91%)	17 (9%)	9	10
1	B	190/194 (98%)	152 (80%)	38 (20%)	1	1
All	All	373/388 (96%)	318 (85%)	55 (15%)	3	3

All (55) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	3	GLN
1	A	5	ARG
1	A	8	LEU
1	A	9	SER
1	A	48	LYS
1	A	62	SER
1	A	85	SER

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<b>Mol</b>	<b>Chain</b>	<b>Res</b>	<b>Type</b>
1	A	88	ARG
1	A	118	LYS
1	A	129	ARG
1	A	145	SER
1	A	152	ARG
1	A	169	GLN
1	A	172	ARG
1	A	176	ARG
1	A	183	ILE
1	A	191	LYS
1	B	5	ARG
1	B	9	SER
1	B	15	GLU
1	B	23	GLN
1	B	25	SER
1	B	39	VAL
1	B	43	ASN
1	B	45	LYS
1	B	46	ARG
1	B	47	ASP
1	B	48	LYS
1	B	66	LYS
1	B	74	LEU
1	B	79	LYS
1	B	81	ILE
1	B	88	ARG
1	B	91	GLU
1	B	103	ASN
1	B	104	SER
1	B	109	GLU
1	B	114	ARG
1	B	118	LYS
1	B	131	ILE
1	B	136	ARG
1	B	140	SER
1	B	142	LEU
1	B	155	ARG
1	B	165	ILE
1	B	170	VAL
1	B	176	ARG
1	B	184	ARG
1	B	186	LYS

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Mol	Chain	Res	Type
1	B	191	LYS
1	B	193	LEU
1	B	202	GLU
1	B	203	ARG
1	B	215	LYS
1	B	227	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	3	GLN
1	A	115	HIS
1	A	177	HIS
1	B	3	GLN
1	B	43	ASN
1	B	182	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 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

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	218/232 (93%)	-0.13	9 (4%) 37 44	7, 20, 52, 88	0
1	B	227/232 (97%)	0.16	10 (4%) 34 41	11, 31, 61, 77	0
All	All	445/464 (95%)	0.02	19 (4%) 35 42	7, 26, 57, 88	0

All (19) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	62	SER	5.3
1	A	229	GLN	4.7
1	B	129	ARG	4.3
1	B	181	LEU	3.6
1	A	61	ALA	3.4
1	B	103	ASN	3.0
1	B	200	ARG	2.9
1	A	71	PHE	2.6
1	B	180	TYR	2.6
1	B	45	LYS	2.5
1	B	176	ARG	2.4
1	A	224	ARG	2.3
1	A	63	ALA	2.3
1	A	228	ILE	2.3
1	A	227	LEU	2.3
1	A	176	ARG	2.2
1	B	8	LEU	2.1
1	B	197	ILE	2.0
1	B	72	ALA	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 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.