



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 26, 2026 – 11:31 AM UTC

PDB ID : 5MBT / pdb_00005mbt
Title : CeuE (H227L, Y288F variant) a periplasmic protein from *Campylobacter jejuni*
Authors : Wilde, E.J.; Blagova, E.V.; Hughes, A.; Raines, D.J.; Moroz, O.V.; Turkenburg, J.P.; Duhme-Klair, A.-K.; Wilson, K.S.
Deposited on : 2016-11-08
Resolution : 1.80 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

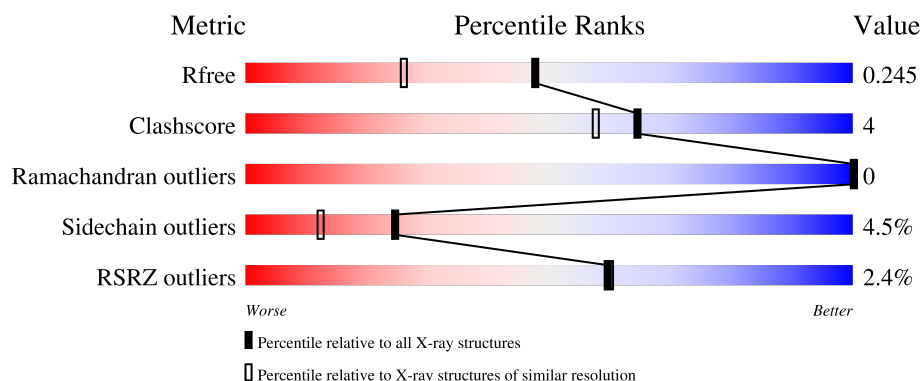
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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 $\leq 5\%$. 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	291	4% 89% 7% ..
1	B	291	2% 86% 10% ..
1	C	291	% 82% 14% ..

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6486 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 Enterochelin uptake periplasmic binding protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	282	Total	C	N	O	S	0	0	0
			2088	1360	335	390	3			
1	B	284	Total	C	N	O	S	0	3	0
			2142	1389	340	410	3			
1	C	282	Total	C	N	O	S	0	2	0
			2135	1379	351	402	3			

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	20	GLY	-	expression tag	UNP Q0P8Q4
A	21	PRO	-	expression tag	UNP Q0P8Q4
A	22	ALA	-	expression tag	UNP Q0P8Q4
A	23	MET	-	expression tag	UNP Q0P8Q4
A	227	LEU	HIS	engineered mutation	UNP Q0P8Q4
A	288	PHE	TYR	engineered mutation	UNP Q0P8Q4
B	20	GLY	-	expression tag	UNP Q0P8Q4
B	21	PRO	-	expression tag	UNP Q0P8Q4
B	22	ALA	-	expression tag	UNP Q0P8Q4
B	23	MET	-	expression tag	UNP Q0P8Q4
B	227	LEU	HIS	engineered mutation	UNP Q0P8Q4
B	288	PHE	TYR	engineered mutation	UNP Q0P8Q4
C	20	GLY	-	expression tag	UNP Q0P8Q4
C	21	PRO	-	expression tag	UNP Q0P8Q4
C	22	ALA	-	expression tag	UNP Q0P8Q4
C	23	MET	-	expression tag	UNP Q0P8Q4
C	227	LEU	HIS	engineered mutation	UNP Q0P8Q4
C	288	PHE	TYR	engineered mutation	UNP Q0P8Q4

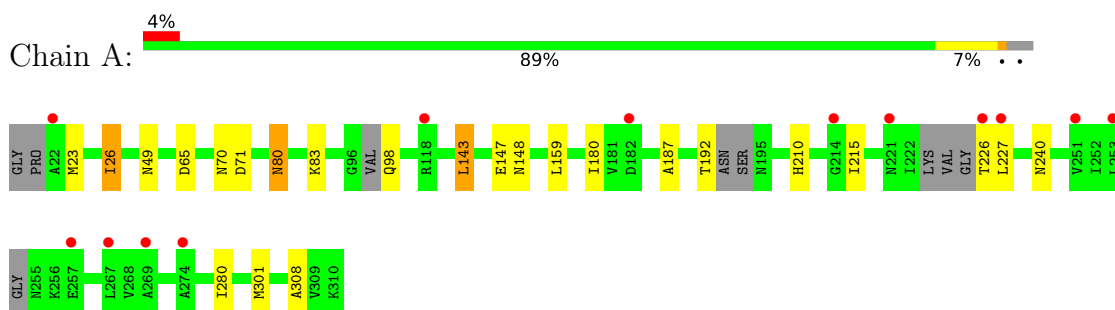
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	47	Total 47	O 47	0	0
2	B	39	Total 39	O 39	0	0
2	C	35	Total 35	O 35	0	0

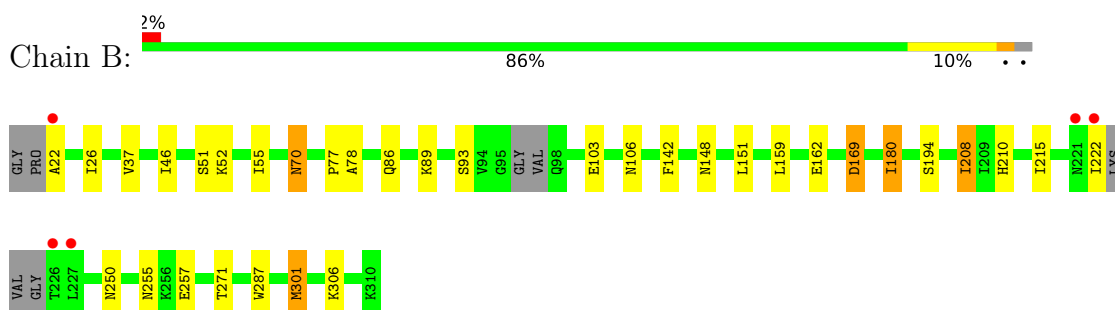
3 Residue-property plots

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.

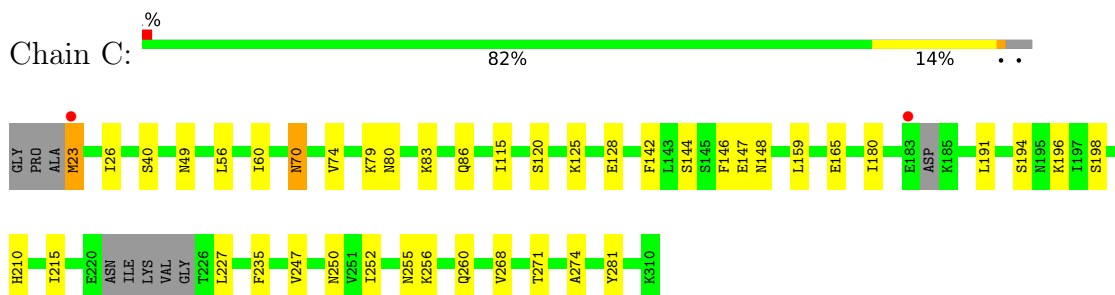
- Molecule 1: Enterochelin uptake periplasmic binding protein



- Molecule 1: Enterochelin uptake periplasmic binding protein



- Molecule 1: Enterochelin uptake periplasmic binding protein



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	57.16Å 62.68Å 67.09Å 82.73° 77.33° 76.54°	Depositor
Resolution (Å)	60.77 – 1.80 60.77 – 1.80	Depositor EDS
% Data completeness (in resolution range)	96.2 (60.77-1.80) 96.2 (60.77-1.80)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.74 (at 1.80Å)	Xtriage
Refinement program	REFMAC 5.8.0155	Depositor
R, R_{free}	0.195 , 0.240 0.202 , 0.245	Depositor DCC
R_{free} test set	3985 reflections (4.88%)	wwPDB-VP
Wilson B-factor (Å ²)	31.7	Xtriage
Anisotropy	0.041	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 22.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	6486	wwPDB-VP
Average B, all atoms (Å ²)	35.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.03% 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

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	1.26	7/2116 (0.3%)	1.14	3/2857 (0.1%)
1	B	1.25	2/2181 (0.1%)	1.15	4/2954 (0.1%)
1	C	1.19	4/2171 (0.2%)	1.14	4/2934 (0.1%)
All	All	1.23	13/6468 (0.2%)	1.14	11/8745 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1

All (13) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	301	MET	SD-CE	-8.14	1.59	1.79
1	A	49	ASN	CA-C	6.66	1.58	1.53
1	C	49	ASN	C-O	6.57	1.26	1.23
1	C	49	ASN	CA-C	6.56	1.57	1.53
1	B	22	ALA	C-N	6.40	1.42	1.33
1	A	49	ASN	N-CA	-5.90	1.41	1.46
1	A	26	ILE	N-CA	-5.83	1.39	1.46
1	A	65	ASP	C-O	5.82	1.30	1.24
1	A	187	ALA	CA-C	-5.48	1.46	1.52
1	C	146	PHE	C-O	5.42	1.30	1.24
1	A	240	ASN	CA-CB	5.25	1.57	1.52
1	C	235	PHE	N-CA	5.22	1.52	1.46
1	A	301	MET	SD-CE	-5.20	1.66	1.79

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	22	ALA	CA-C-N	9.45	135.42	121.72
1	B	22	ALA	C-N-CA	9.45	135.42	121.72
1	B	22	ALA	O-C-N	-7.73	110.64	123.00
1	B	169	ASP	N-CA-CB	6.61	119.83	110.12
1	C	74	VAL	CB-CA-C	-6.01	103.33	110.84
1	C	120	SER	N-CA-C	5.96	118.54	111.33
1	C	165	GLU	N-CA-CB	5.75	118.58	110.12
1	A	80	ASN	N-CA-C	5.61	122.75	110.80
1	C	252	ILE	N-CA-C	5.56	116.34	110.72
1	A	301	MET	CG-SD-CE	-5.50	88.80	100.90
1	A	143	LEU	N-CA-C	5.30	117.06	111.28

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	80	ASN	Peptide

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	2088	0	2068	9	0
1	B	2142	0	2132	20	0
1	C	2135	0	2159	20	0
2	A	47	0	0	4	0
2	B	39	0	0	0	0
2	C	35	0	0	7	0
All	All	6486	0	6359	49	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 (49) 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:C:23:MET:HA	2:C:432:HOH:O	1.66	0.96

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:26:ILE:H	1:C:148:ASN:HD21	1.23	0.86
1:A:147:GLU:CG	2:A:409:HOH:O	2.30	0.78
1:B:26:ILE:H	1:B:148:ASN:HD21	1.27	0.78
1:B:142:PHE:CG	1:B:208:ILE:HD11	2.20	0.76
1:B:142:PHE:CD1	1:B:208:ILE:HD11	2.22	0.75
1:A:26:ILE:H	1:A:148:ASN:HD21	1.35	0.74
1:C:268:VAL:O	1:C:271[A]:THR:HG22	1.87	0.74
1:B:37:VAL:HG21	1:B:46:ILE:HD12	1.79	0.65
1:C:70:ASN:HD22	1:C:70:ASN:H	1.45	0.63
1:B:78:ALA:HB3	1:B:93:SER:HB2	1.82	0.62
1:C:83:LYS:HA	1:C:86:GLN:HG2	1.84	0.59
1:C:271[A]:THR:HG23	1:C:274:ALA:H	1.68	0.58
1:A:210:HIS:HD2	1:A:215:ILE:O	1.87	0.57
1:B:194:SER:H	1:B:250:ASN:HD21	1.53	0.57
1:A:192:THR:C	2:A:407:HOH:O	2.47	0.57
1:B:70:ASN:H	1:B:70:ASN:HD22	1.53	0.54
1:C:194:SER:H	1:C:250:ASN:HD21	1.53	0.54
1:C:210:HIS:HD2	1:C:215:ILE:O	1.91	0.53
1:C:194:SER:N	1:C:250:ASN:HD21	2.06	0.53
1:A:70:ASN:H	1:A:70:ASN:HD22	1.56	0.53
1:C:227:LEU:CB	2:C:433:HOH:O	2.56	0.53
1:B:194:SER:HA	1:B:257:GLU:HG3	1.91	0.51
1:B:180:ILE:HD11	1:B:306:LYS:HG3	1.92	0.50
1:B:26:ILE:H	1:B:148:ASN:ND2	2.04	0.50
1:C:147:GLU:CD	2:C:431:HOH:O	2.54	0.49
1:A:71:ASP:OD1	2:A:401:HOH:O	2.20	0.49
1:B:194:SER:N	1:B:250:ASN:HD21	2.11	0.49
1:C:80:ASN:N	2:C:401:HOH:O	1.91	0.48
1:A:83:LYS:NZ	2:A:403:HOH:O	2.41	0.47
1:C:56:LEU:HD12	1:C:115:ILE:HG22	1.98	0.45
1:C:210:HIS:HE1	2:C:408:HOH:O	2.01	0.43
1:B:162:GLU:OE1	1:B:162:GLU:N	2.48	0.43
1:C:79:LYS:CB	2:C:434:HOH:O	2.66	0.43
1:C:250:ASN:HD22	1:C:255:ASN:HD22	1.65	0.43
1:C:260:GLN:HG3	1:C:281:TYR:CZ	2.53	0.43
1:A:23:MET:HE2	1:A:23:MET:HB3	1.99	0.43
1:B:142:PHE:CG	1:B:208:ILE:CD1	2.97	0.42
1:B:287:TRP:CD2	1:B:301:MET:CE	3.03	0.41
1:C:142:PHE:CD1	1:C:142:PHE:C	2.98	0.41
1:B:250:ASN:HD22	1:B:255:ASN:HD22	1.67	0.41
1:C:191:LEU:HA	1:C:247:VAL:O	2.20	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:86:GLN:HE22	1:B:89:LYS:HD3	1.85	0.41
1:B:151:LEU:HD23	1:B:151:LEU:HA	1.89	0.41
1:A:280:ILE:HD12	1:A:308:ALA:HB1	2.03	0.41
1:B:208:ILE:HA	1:B:208:ILE:HD12	1.77	0.41
1:C:23:MET:HA	2:C:430:HOH:O	2.20	0.41
1:B:55:ILE:O	1:B:77:PRO:HD3	2.21	0.40
1:B:210:HIS:HD2	1:B:215:ILE:O	2.04	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	272/291 (94%)	264 (97%)	8 (3%)	0	100	100
1	B	281/291 (97%)	270 (96%)	11 (4%)	0	100	100
1	C	278/291 (96%)	266 (96%)	12 (4%)	0	100	100
All	All	831/873 (95%)	800 (96%)	31 (4%)	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	208/252 (82%)	202 (97%)	6 (3%)	37	25
1	B	221/252 (88%)	209 (95%)	12 (5%)	20	8
1	C	226/252 (90%)	214 (95%)	12 (5%)	20	9
All	All	655/756 (87%)	625 (95%)	30 (5%)	24	12

All (30) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	98	GLN
1	A	143	LEU
1	A	159	LEU
1	A	180	ILE
1	A	226	THR
1	A	227	LEU
1	B	51	SER
1	B	52	LYS
1	B	70	ASN
1	B	103	GLU
1	B	106	ASN
1	B	159	LEU
1	B	169	ASP
1	B	180	ILE
1	B	208	ILE
1	B	222	ILE
1	B	271[A]	THR
1	B	271[B]	THR
1	C	23	MET
1	C	40	SER
1	C	60	ILE
1	C	70	ASN
1	C	125	LYS
1	C	128	GLU
1	C	144	SER
1	C	159	LEU
1	C	180	ILE
1	C	196	LYS
1	C	198	SER
1	C	256	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (25) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	70	ASN
1	A	148	ASN
1	A	172	ASN
1	A	210	HIS
1	A	216	ASN
1	A	255	ASN
1	A	276	ASN
1	B	70	ASN
1	B	86	GLN
1	B	90	ASN
1	B	148	ASN
1	B	172	ASN
1	B	210	HIS
1	B	216	ASN
1	B	250	ASN
1	C	70	ASN
1	C	86	GLN
1	C	90	ASN
1	C	148	ASN
1	C	193	ASN
1	C	210	HIS
1	C	216	ASN
1	C	250	ASN
1	C	276	ASN
1	C	307	ASN

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 [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, 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	282/291 (96%)	0.18	13 (4%) 37 36	16, 34, 52, 73	6 (2%)
1	B	284/291 (97%)	0.03	5 (1%) 67 68	19, 34, 52, 72	3 (1%)
1	C	282/291 (96%)	0.11	2 (0%) 84 85	18, 36, 52, 60	3 (1%)
All	All	848/873 (97%)	0.11	20 (2%) 59 60	16, 34, 52, 73	12 (1%)

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	23	MET	6.4
1	B	222	ILE	6.1
1	A	221	ASN	4.9
1	A	214	GLY	4.5
1	A	253	LEU	4.4
1	A	22	ALA	3.6
1	A	227	LEU	3.3
1	C	183	GLU	2.8
1	A	257	GLU	2.6
1	A	118	ARG	2.5
1	A	274	ALA	2.4
1	B	227	LEU	2.4
1	A	269	ALA	2.4
1	A	226	THR	2.3
1	B	221	ASN	2.3
1	A	251	VAL	2.3
1	B	22	ALA	2.3
1	A	182	ASP	2.1
1	B	226	THR	2.0
1	A	267	LEU	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.