



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 12, 2026 – 04:55 PM UTC

PDB ID : 4E56 / pdb_00004e56
Title : Crystal Structure of spacer 8aa-shortened cephalosporin acylase mutant
Authors : Yin, J.; Zhang, Z.; Wu, G.; Huang, X.
Deposited on : 2012-03-14
Resolution : 2.20 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
Xtrriage (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

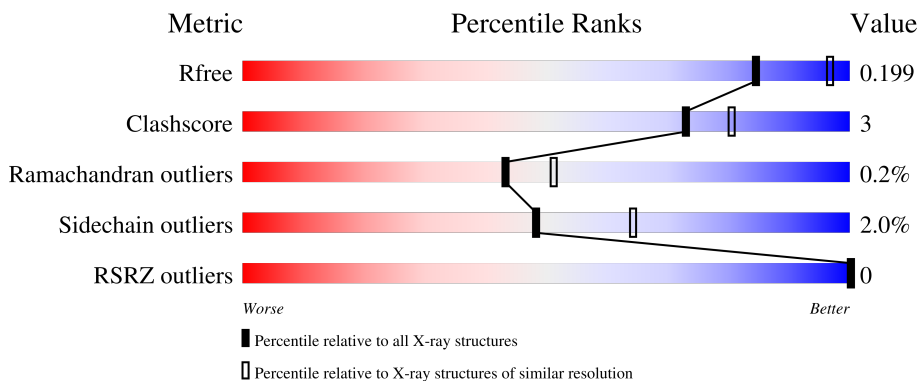
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION


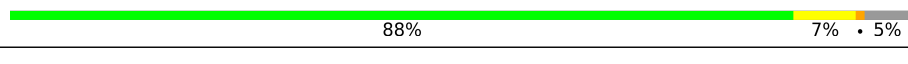
The reported resolution of this entry is 2.20 Å.

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	6164 (2.20-2.20)
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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	696	 88% 7% 5%
1	B	696	 88% 7% 5%

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 11706 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 Cephalosporin acylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	664	5234	3314	924	984	12	0	0	0
1	B	664	5234	3314	924	984	12	0	0	0

There are 50 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	expression tag	UNP O86089
A	2	GLY	-	expression tag	UNP O86089
A	3	ILE	-	expression tag	UNP O86089
A	127	GLU	ASP	SEE REMARK 999	UNP O86089
A	?	-	ASP	deletion	UNP O86089
A	?	-	PRO	deletion	UNP O86089
A	?	-	PRO	deletion	UNP O86089
A	?	-	ASP	deletion	UNP O86089
A	?	-	LEU	deletion	UNP O86089
A	?	-	ALA	deletion	UNP O86089
A	?	-	ASP	deletion	UNP O86089
A	?	-	GLN	deletion	UNP O86089
A	164	ALA	SER	engineered mutation	UNP O86089
A	685	LEU	-	expression tag	UNP O86089
A	686	ALA	-	expression tag	UNP O86089
A	687	ALA	-	expression tag	UNP O86089
A	688	ALA	-	expression tag	UNP O86089
A	689	LEU	-	expression tag	UNP O86089
A	690	GLU	-	expression tag	UNP O86089
A	691	HIS	-	expression tag	UNP O86089
A	692	HIS	-	expression tag	UNP O86089
A	693	HIS	-	expression tag	UNP O86089
A	694	HIS	-	expression tag	UNP O86089
A	695	HIS	-	expression tag	UNP O86089
A	696	HIS	-	expression tag	UNP O86089

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Chain	Residue	Modelled	Actual	Comment	Reference
B	1	MET	-	expression tag	UNP O86089
B	2	GLY	-	expression tag	UNP O86089
B	3	ILE	-	expression tag	UNP O86089
B	127	GLU	ASP	SEE REMARK 999	UNP O86089
B	?	-	ASP	deletion	UNP O86089
B	?	-	PRO	deletion	UNP O86089
B	?	-	PRO	deletion	UNP O86089
B	?	-	ASP	deletion	UNP O86089
B	?	-	LEU	deletion	UNP O86089
B	?	-	ALA	deletion	UNP O86089
B	?	-	ASP	deletion	UNP O86089
B	?	-	GLN	deletion	UNP O86089
B	164	ALA	SER	engineered mutation	UNP O86089
B	685	LEU	-	expression tag	UNP O86089
B	686	ALA	-	expression tag	UNP O86089
B	687	ALA	-	expression tag	UNP O86089
B	688	ALA	-	expression tag	UNP O86089
B	689	LEU	-	expression tag	UNP O86089
B	690	GLU	-	expression tag	UNP O86089
B	691	HIS	-	expression tag	UNP O86089
B	692	HIS	-	expression tag	UNP O86089
B	693	HIS	-	expression tag	UNP O86089
B	694	HIS	-	expression tag	UNP O86089
B	695	HIS	-	expression tag	UNP O86089
B	696	HIS	-	expression tag	UNP O86089

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total Ca 1 1	0	0
2	B	1	Total Ca 1 1	0	0


- Molecule 3 is water.

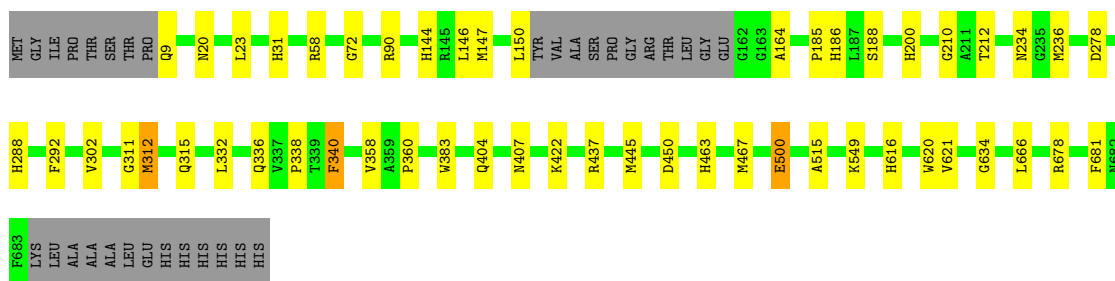
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	632	Total O 632 632	0	0
3	B	604	Total O 604 604	0	0

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.

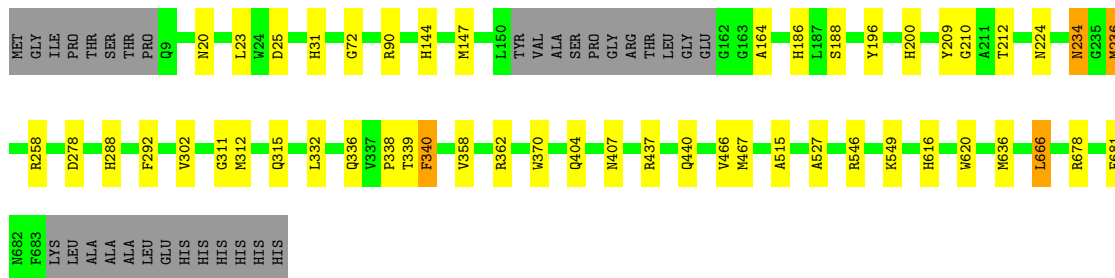
- Molecule 1: Cephalosporin acylase

Chain A:  88% 7% 5%



- Molecule 1: Cephalosporin acylase

Chain B:  88% 7% 5%



4 Data and refinement statistics i

Property	Value	Source
Space group	P 41	Depositor
Cell constants a, b, c, α , β , γ	73.74Å 73.74Å 383.73Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.32 – 2.20 48.32 – 2.20	Depositor EDS
% Data completeness (in resolution range)	99.9 (48.32-2.20) 99.9 (48.32-2.20)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.35 (at 2.20Å)	Xtrriage
Refinement program	REFMAC 5.6.0117	Depositor
R, R_{free}	0.173 , 0.202 0.171 , 0.199	Depositor DCC
R_{free} test set	5181 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	30.9	Xtrriage
Anisotropy	0.038	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 22.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.476 for h,-k,-l	Xtrriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	11706	wwPDB-VP
Average B, all atoms (Å ²)	34.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.57% 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](#)

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

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	0.61	0/5385	0.74	3/7355 (0.0%)
1	B	0.61	0/5385	0.74	3/7355 (0.0%)
All	All	0.61	0/10770	0.74	6/14710 (0.0%)

There are no bond length outliers.

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	72	GLY	CA-C-N	6.83	127.11	119.32
1	B	72	GLY	C-N-CA	6.83	127.11	119.32
1	A	72	GLY	CA-C-N	6.19	127.58	119.84
1	A	72	GLY	C-N-CA	6.19	127.58	119.84
1	B	210	GLY	N-CA-C	6.12	118.22	110.38
1	A	210	GLY	N-CA-C	5.73	117.72	110.38

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	5234	0	4981	34	0
1	B	5234	0	4981	32	0
2	A	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	1	0	0	0	0
3	A	632	0	0	8	0
3	B	604	0	0	3	0
All	All	11706	0	9962	66	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 3.

All (66) 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:147:MET:HE1	1:A:340:PHE:HE1	1.22	1.05
1:B:164:ALA:H	1:B:407:ASN:HD21	1.12	0.95
1:B:315:GLN:HE22	1:B:336:GLN:H	1.22	0.87
1:A:164:ALA:H	1:A:407:ASN:HD21	1.21	0.86
1:B:147:MET:HE1	1:B:340:PHE:HE1	1.43	0.83
1:A:315:GLN:HE22	1:A:336:GLN:H	1.26	0.81
1:A:407:ASN:HD22	1:A:437:ARG:HH22	1.31	0.79
1:B:407:ASN:HD22	1:B:437:ARG:HH22	1.29	0.77
1:A:147:MET:HE1	1:A:340:PHE:CE1	2.14	0.73
1:B:315:GLN:NE2	1:B:336:GLN:H	1.88	0.71
1:A:311:GLY:H	1:A:336:GLN:HE21	1.36	0.70
1:B:311:GLY:H	1:B:336:GLN:HE21	1.37	0.70
1:A:90:ARG:HH11	1:A:144:HIS:HE2	1.37	0.69
1:B:467:MET:HE1	1:B:515:ALA:HB1	1.74	0.68
1:A:315:GLN:NE2	1:A:336:GLN:H	1.91	0.67
1:B:196:TYR:HB3	1:B:636:MET:HE1	1.77	0.66
1:B:467:MET:HE1	1:B:515:ALA:CB	2.25	0.65
1:B:90:ARG:HH11	1:B:144:HIS:HE2	1.44	0.63
1:A:23:LEU:HD22	1:A:678:ARG:HG2	1.80	0.63
1:A:467:MET:HE1	1:A:515:ALA:CB	2.32	0.60
1:B:147:MET:HE1	1:B:340:PHE:CE1	2.33	0.59
1:A:164:ALA:N	1:A:407:ASN:HD21	1.99	0.58
1:B:23:LEU:HD22	1:B:678:ARG:HG2	1.85	0.58
1:B:164:ALA:N	1:B:407:ASN:HD21	1.92	0.56
1:A:467:MET:HE1	1:A:515:ALA:HB1	1.89	0.54
1:A:288:HIS:HE1	3:A:1084:HOH:O	1.91	0.53
1:B:31:HIS:ND1	1:B:200:HIS:HD2	2.06	0.52
1:A:422:LYS:HG3	3:A:1113:HOH:O	2.08	0.52
1:A:463:HIS:CD2	1:A:500:GLU:HG3	2.44	0.51
1:B:527:ALA:O	1:B:546:ARG:NH1	2.44	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:292:PHE:HE1	1:B:302:VAL:HG12	1.77	0.49
1:A:31:HIS:ND1	1:A:200:HIS:HD2	2.11	0.48
1:B:288:HIS:HE1	3:B:1169:HOH:O	1.97	0.47
1:A:407:ASN:ND2	1:A:437:ARG:HH22	2.07	0.47
1:B:338:PRO:HA	1:B:358:VAL:HG23	1.98	0.46
1:A:58:ARG:HD2	3:A:1197:HOH:O	2.16	0.46
1:B:311:GLY:H	1:B:336:GLN:NE2	2.11	0.46
1:A:186:HIS:HD2	3:A:1005:HOH:O	1.99	0.46
1:B:620:TRP:HE3	1:B:636:MET:HG2	1.81	0.45
1:A:9:GLN:N	3:A:904:HOH:O	2.50	0.45
1:B:25:ASP:OD1	1:B:25:ASP:C	2.60	0.44
1:A:338:PRO:HA	1:A:358:VAL:HG23	1.99	0.44
1:B:31:HIS:ND1	1:B:200:HIS:CD2	2.84	0.44
1:A:147:MET:CE	1:A:340:PHE:HE1	2.09	0.44
1:A:292:PHE:HE1	1:A:302:VAL:HG12	1.83	0.43
1:A:146:LEU:HA	1:A:150:LEU:HD12	1.99	0.43
1:B:209:TYR:CD1	1:B:666:LEU:HD22	2.53	0.43
1:B:362:ARG:HD2	1:B:370:TRP:CE2	2.53	0.43
1:B:188:SER:HA	1:B:616:HIS:HB3	1.99	0.43
1:B:196:TYR:CB	1:B:636:MET:HE1	2.46	0.43
1:A:186:HIS:CD2	3:A:1005:HOH:O	2.71	0.43
1:B:339:THR:O	1:B:340:PHE:HB2	2.19	0.43
1:A:500:GLU:HG2	3:A:855:HOH:O	2.18	0.42
1:A:188:SER:HA	1:A:616:HIS:HB3	2.00	0.42
1:A:20:ASN:HB3	1:A:681:PHE:CE1	2.54	0.42
1:A:31:HIS:ND1	1:A:200:HIS:CD2	2.88	0.42
1:A:312:MET:HG2	3:A:1022:HOH:O	2.20	0.41
1:B:20:ASN:HB3	1:B:681:PHE:CE1	2.55	0.41
1:A:445:MET:HE2	1:A:445:MET:HA	2.02	0.41
1:A:360:PRO:HB3	1:A:383:TRP:CD2	2.55	0.41
1:B:440:GLN:HG2	1:B:466:VAL:HG21	2.03	0.41
1:B:224:ASN:HB2	3:B:883:HOH:O	2.21	0.41
1:A:621:VAL:O	1:A:634:GLY:HA2	2.21	0.40
1:B:234:ASN:ND2	1:B:236:MET:H	2.19	0.40
1:B:186:HIS:HD2	3:B:989:HOH:O	2.05	0.40
1:A:185:PRO:HD2	1:A:620:TRP: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	
1	A	660/696 (95%)	648 (98%)	11 (2%)	1 (0%)	43	51
1	B	660/696 (95%)	647 (98%)	12 (2%)	1 (0%)	43	51
All	All	1320/1392 (95%)	1295 (98%)	23 (2%)	2 (0%)	43	51

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	340	PHE
1	B	340	PHE

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	537/562 (96%)	526 (98%)	11 (2%)	48	64
1	B	537/562 (96%)	527 (98%)	10 (2%)	50	66
All	All	1074/1124 (96%)	1053 (98%)	21 (2%)	48	64

All (21) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	212	THR
1	A	234	ASN
1	A	236	MET
1	A	278	ASP

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Mol	Chain	Res	Type
1	A	312	MET
1	A	332	LEU
1	A	404	GLN
1	A	450	ASP
1	A	500	GLU
1	A	549	LYS
1	A	666	LEU
1	B	212	THR
1	B	234	ASN
1	B	236	MET
1	B	258	ARG
1	B	278	ASP
1	B	312	MET
1	B	332	LEU
1	B	404	GLN
1	B	549	LYS
1	B	666	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (26) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	148	ASN
1	A	186	HIS
1	A	200	HIS
1	A	234	ASN
1	A	241	ASN
1	A	288	HIS
1	A	315	GLN
1	A	336	GLN
1	A	352	ASN
1	A	356	ASN
1	A	404	GLN
1	A	407	ASN
1	B	148	ASN
1	B	186	HIS
1	B	200	HIS
1	B	234	ASN
1	B	247	GLN
1	B	288	HIS
1	B	315	GLN
1	B	336	GLN
1	B	352	ASN

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Mol	Chain	Res	Type
1	B	356	ASN
1	B	404	GLN
1	B	407	ASN
1	B	431	GLN
1	B	521	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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 [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	664/696 (95%)	-1.67	0 100 100	24, 31, 50, 66	0
1	B	664/696 (95%)	-1.66	0 100 100	24, 32, 50, 69	0
All	All	1328/1392 (95%)	-1.66	0 100 100	24, 32, 51, 69	0

There are no RSRZ outliers to report.

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](#)

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, 95th 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
2	CA	A	701	1/1	1.00	0.01	31,31,31,31	0
2	CA	B	701	1/1	1.00	0.01	30,30,30,30	0

6.5 Other polymers [i](#)

There are no such residues in this entry.