



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 04:01 PM UTC

PDB ID : 6S3G / pdb_00006s3g
Title : Crystal Structure of lipase from *Geobacillus stearothermophilus* T6 variant A187C/F291C
Authors : Gihaz, S.; Bash, Y.; Rush, I.; Shahar, A.; Pazy, Y.; Fishman, A.
Deposited on : 2019-06-25
Resolution : 1.90 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

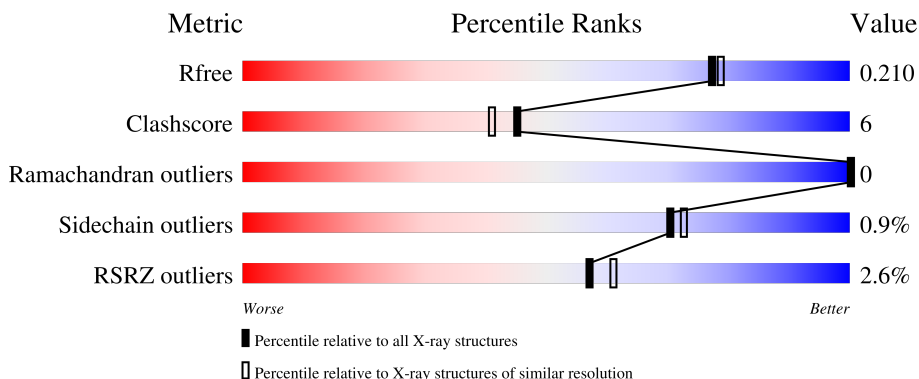
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

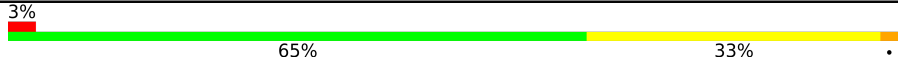
The reported resolution of this entry is 1.90 Å.

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	7789 (1.90-1.90)
Clashscore	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)
RSRZ outliers	180081	7790 (1.90-1.90)

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	392	

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 3373 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 Lipase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	392	Total	C	N	O	S	0	0	0
			3103	1966	555	572	10			

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	187	CYS	ALA	engineered mutation	UNP Q93A71
A	291	CYS	PHE	engineered mutation	UNP Q93A71
A	323	ALA	THR	engineered mutation	UNP Q93A71
A	390	HIS	-	expression tag	UNP Q93A71
A	391	HIS	-	expression tag	UNP Q93A71
A	392	HIS	-	expression tag	UNP Q93A71
A	393	HIS	-	expression tag	UNP Q93A71
A	394	HIS	-	expression tag	UNP Q93A71
A	395	HIS	-	expression tag	UNP Q93A71

- Molecule 2 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Zn	0	0
			1	1		

- Molecule 3 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Ca	0	0
			1	1		

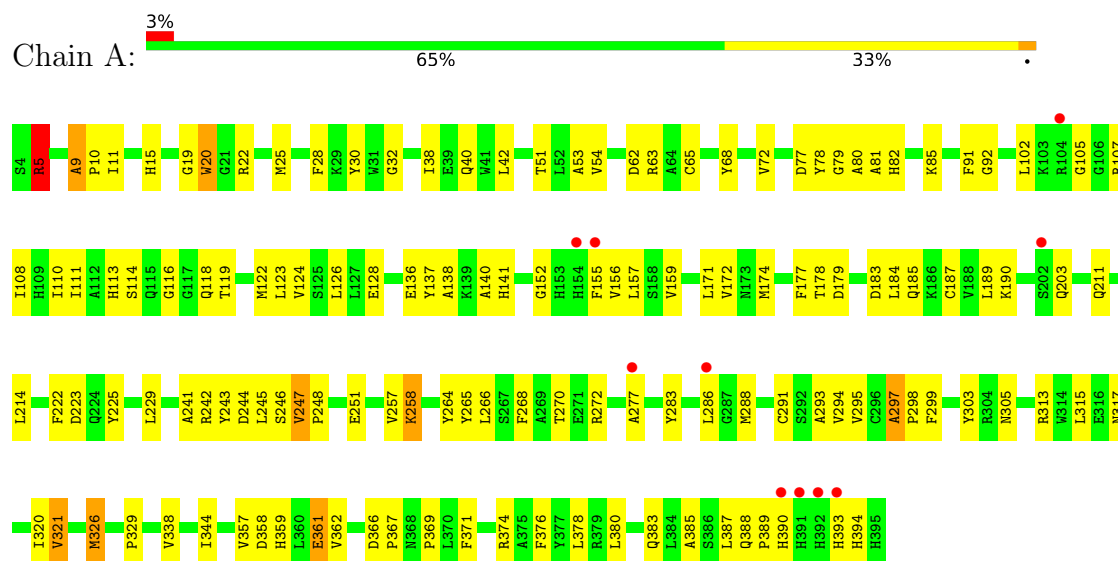
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	268	Total 268	O 268	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: Lipase



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	50.07Å 71.31Å 113.79Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	44.48 – 1.90 44.48 – 1.90	Depositor EDS
% Data completeness (in resolution range)	100.0 (44.48-1.90) 99.8 (44.48-1.90)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.91 (at 1.89Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.188 , 0.208 0.190 , 0.210	Depositor DCC
R_{free} test set	1633 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å ²)	24.5	Xtriage
Anisotropy	0.141	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 39.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	3373	wwPDB-VP
Average B, all atoms (Å ²)	27.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.92% 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, ZN

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	1.96	92/3192 (2.9%)	1.11	13/4340 (0.3%)

All (92) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	111	ILE	C-O	-7.53	1.16	1.24
1	A	272	ARG	C-O	-7.40	1.17	1.24
1	A	119	THR	C-O	-7.31	1.15	1.24
1	A	177	PHE	C-O	-7.05	1.15	1.24
1	A	242	ARG	C-O	-7.00	1.16	1.24
1	A	80	ALA	C-O	-6.97	1.16	1.24
1	A	247	VAL	C-O	-6.92	1.18	1.24
1	A	62	ASP	C-O	-6.84	1.16	1.24
1	A	172	VAL	C-O	-6.84	1.14	1.24
1	A	380	LEU	C-O	-6.84	1.16	1.24
1	A	338	VAL	C-O	-6.80	1.17	1.23
1	A	85	LYS	C-O	-6.61	1.16	1.24
1	A	20	TRP	C-O	-6.58	1.16	1.23
1	A	65	CYS	C-O	-6.50	1.16	1.24
1	A	38	ILE	C-O	-6.47	1.16	1.24
1	A	185	GLN	C-O	-6.34	1.16	1.24
1	A	297	ALA	C-O	-6.33	1.18	1.24
1	A	122	MET	C-O	-6.29	1.16	1.24
1	A	54	VAL	C-O	-6.28	1.16	1.23
1	A	51	THR	C-O	-6.26	1.16	1.24
1	A	288	MET	C-O	-6.22	1.16	1.23
1	A	315	LEU	C-O	-6.22	1.16	1.24
1	A	245	LEU	C-O	-6.20	1.15	1.24
1	A	159	VAL	C-O	-6.17	1.17	1.24
1	A	110	ILE	C-O	-6.08	1.17	1.24
1	A	359	HIS	C-O	-6.07	1.17	1.24

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	258	LYS	C-O	-6.01	1.16	1.23
1	A	136	GLU	C-O	-6.00	1.17	1.24
1	A	179	ASP	C-O	-5.99	1.17	1.24
1	A	246	SER	C-O	-5.96	1.15	1.23
1	A	183	ASP	C-O	-5.94	1.16	1.24
1	A	53	ALA	C-O	-5.92	1.17	1.24
1	A	243	TYR	C-O	-5.91	1.17	1.24
1	A	244	ASP	C-O	-5.91	1.16	1.24
1	A	81	ALA	C-O	-5.88	1.17	1.24
1	A	361	GLU	C-O	-5.88	1.17	1.24
1	A	116	GLY	C-O	-5.88	1.16	1.23
1	A	91	PHE	C-O	-5.87	1.17	1.23
1	A	214	LEU	C-O	-5.86	1.16	1.24
1	A	394	HIS	C-O	-5.86	1.17	1.23
1	A	137	TYR	C-O	-5.85	1.17	1.24
1	A	241	ALA	C-O	-5.81	1.17	1.24
1	A	63	ARG	C-O	-5.80	1.17	1.24
1	A	141	HIS	C-O	-5.79	1.16	1.24
1	A	72	VAL	C-O	-5.79	1.18	1.24
1	A	28	PHE	C-O	-5.78	1.17	1.24
1	A	229	LEU	C-O	-5.77	1.17	1.24
1	A	376	PHE	C-O	-5.71	1.17	1.24
1	A	329	PRO	C-O	-5.69	1.16	1.23
1	A	152	GLY	C-O	-5.69	1.16	1.24
1	A	378	LEU	C-O	-5.66	1.17	1.24
1	A	92	GLY	C-O	-5.66	1.16	1.23
1	A	79	GLY	C-O	-5.65	1.16	1.23
1	A	123	LEU	C-O	-5.55	1.17	1.24
1	A	283	TYR	C-O	-5.51	1.16	1.24
1	A	128	GLU	C-O	-5.50	1.17	1.24
1	A	11	ILE	C-O	-5.49	1.17	1.24
1	A	77	ASP	C-O	-5.47	1.17	1.24
1	A	118	GLN	C-O	-5.46	1.17	1.24
1	A	313	ARG	C-O	-5.45	1.17	1.24
1	A	178	THR	C-O	-5.44	1.17	1.24
1	A	114	SER	C-O	-5.43	1.19	1.24
1	A	222	PHE	C-O	-5.41	1.17	1.24
1	A	138	ALA	C-O	-5.41	1.17	1.24
1	A	257	VAL	C-O	-5.39	1.16	1.23
1	A	225	TYR	C-O	-5.38	1.18	1.24
1	A	42	LEU	C-O	-5.38	1.18	1.24
1	A	124	VAL	C-O	-5.38	1.18	1.24

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	68	TYR	C-O	-5.38	1.18	1.24
1	A	22	ARG	C-O	-5.35	1.17	1.24
1	A	156	VAL	C-O	-5.34	1.17	1.23
1	A	126	LEU	C-O	-5.32	1.17	1.24
1	A	268	PHE	C-O	-5.32	1.17	1.24
1	A	321	VAL	C-O	-5.30	1.18	1.24
1	A	371	PHE	C-O	-5.30	1.17	1.24
1	A	157	LEU	C-O	-5.29	1.17	1.24
1	A	82	HIS	C-O	-5.24	1.18	1.24
1	A	113	HIS	C-O	-5.20	1.17	1.24
1	A	251	GLU	C-O	-5.20	1.18	1.24
1	A	9	ALA	C-O	-5.20	1.17	1.24
1	A	374	ARG	C-O	-5.19	1.18	1.24
1	A	78	TYR	C-O	-5.17	1.17	1.24
1	A	32	GLY	C-O	-5.15	1.17	1.23
1	A	223	ASP	C-O	-5.15	1.18	1.24
1	A	362	VAL	C-O	-5.14	1.17	1.24
1	A	211	GLN	C-O	-5.11	1.17	1.24
1	A	393	HIS	C-O	-5.09	1.17	1.24
1	A	299	PHE	C-O	-5.06	1.18	1.24
1	A	140	ALA	C-O	-5.05	1.17	1.24
1	A	305	ASN	C-O	-5.04	1.17	1.23
1	A	369	PRO	C-O	-5.01	1.18	1.24
1	A	40	GLN	C-O	-5.00	1.18	1.24

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	326	MET	N-CA-C	8.15	123.00	112.89
1	A	294	VAL	N-CA-C	7.49	117.57	110.53
1	A	156	VAL	N-CA-C	6.23	117.45	107.73
1	A	295	VAL	N-CA-C	5.98	116.34	111.62
1	A	293	ALA	N-CA-C	5.84	117.65	111.28
1	A	303	TYR	N-CA-C	5.70	117.50	108.67
1	A	315	LEU	N-CA-C	5.54	117.40	111.36
1	A	203	GLN	N-CA-C	5.43	116.88	111.07
1	A	317	ASN	N-CA-C	5.11	116.57	108.96
1	A	5	ARG	N-CA-C	5.11	117.96	110.30
1	A	105	GLY	N-CA-C	5.08	120.73	114.69
1	A	30	TYR	N-CA-C	-5.05	105.67	111.07
1	A	277	ALA	N-CA-C	5.03	117.65	111.82

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	3103	0	2959	35	0
2	A	1	0	0	0	0
3	A	1	0	0	0	0
4	A	268	0	0	0	0
All	All	3373	0	2959	35	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 6.

All (35) 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:171:LEU:CD1	1:A:174:MET:HE2	2.21	0.71
1:A:286:LEU:C	1:A:286:LEU:HD12	2.18	0.69
1:A:171:LEU:HD11	1:A:174:MET:HE2	1.77	0.65
1:A:286:LEU:HD12	1:A:286:LEU:O	2.02	0.60
1:A:5:ARG:HG2	1:A:5:ARG:HH11	1.68	0.59
1:A:297:ALA:HB3	1:A:298:PRO:HD3	1.85	0.59
1:A:344:ILE:HD11	1:A:383:GLN:CD	2.27	0.59
1:A:25:MET:HE1	1:A:189:LEU:HD23	1.85	0.58
1:A:388:GLN:HG3	1:A:390:HIS:H	1.72	0.54
1:A:344:ILE:CD1	1:A:383:GLN:OE1	2.58	0.52
1:A:358:ASP:OD1	1:A:361:GLU:HG3	2.10	0.50
1:A:344:ILE:CD1	1:A:383:GLN:CD	2.84	0.50
1:A:247:VAL:N	1:A:248:PRO:CD	2.74	0.49
1:A:264:TYR:CD1	1:A:387:LEU:HD13	2.47	0.49
1:A:344:ILE:HD12	1:A:383:GLN:OE1	2.13	0.48
1:A:15:HIS:CG	1:A:19:GLY:HA3	2.48	0.48
1:A:321:VAL:HB	1:A:326:MET:CE	2.43	0.48
1:A:366:ASP:OD1	1:A:367:PRO:HD2	2.14	0.47
1:A:5:ARG:NH1	1:A:385:ALA:HB1	2.30	0.47

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:187:CYS:CB	1:A:291:CYS:SG	3.04	0.46
1:A:286:LEU:C	1:A:286:LEU:CD1	2.88	0.46
1:A:184:LEU:HD21	1:A:320:ILE:HD12	1.97	0.45
1:A:102:LEU:HD21	1:A:108:ILE:HG23	2.00	0.43
1:A:155:PHE:N	1:A:155:PHE:CD1	2.86	0.43
1:A:388:GLN:HA	1:A:389:PRO:HD3	1.83	0.43
1:A:5:ARG:HG2	1:A:5:ARG:NH1	2.33	0.43
1:A:171:LEU:HD11	1:A:174:MET:CE	2.47	0.43
1:A:107:ARG:HA	1:A:155:PHE:O	2.19	0.42
1:A:9:ALA:HA	1:A:10:PRO:HD3	1.91	0.42
1:A:266:LEU:HD12	1:A:266:LEU:N	2.34	0.42
1:A:388:GLN:OE1	1:A:389:PRO:HD2	2.20	0.42
1:A:20:TRP:CE2	1:A:25:MET:HG3	2.55	0.41
1:A:10:PRO:HD2	1:A:107:ARG:O	2.21	0.41
1:A:270:THR:HB	1:A:357:VAL:O	2.21	0.41
1:A:265:TYR:C	1:A:266:LEU:HD12	2.47	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	390/392 (100%)	380 (97%)	10 (3%)	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	321/321 (100%)	318 (99%)	3 (1%)	70 73

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	5	ARG
1	A	190	LYS
1	A	258	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	154	HIS
1	A	392	HIS

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 ⓘ

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

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	392/392 (100%)	-0.07	10 (2%) 57 61	15, 25, 42, 82	0

All (10) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	391	HIS	3.7
1	A	392	HIS	3.2
1	A	286	LEU	2.9
1	A	202	SER	2.7
1	A	390	HIS	2.7
1	A	104	ARG	2.3
1	A	155	PHE	2.2
1	A	393	HIS	2.1
1	A	277	ALA	2.1
1	A	154	HIS	2.1

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($\text{\AA}^2$)	Q<0.9
3	CA	A	402	1/1	0.93	0.09	39,39,39,39	1
2	ZN	A	401	1/1	0.99	0.02	21,21,21,21	0

6.5 Other polymers [i](#)

There are no such residues in this entry.