



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 11:31 AM UTC

PDB ID : 5WL8 / pdb_00005wl8
Title : Crystal structure of chalcone isomerase engineered from ancestral inference (epR4)
Authors : Burke, J.R.; Kaltenbach, M.; Tawfik, D.S.; Noel, J.P.
Deposited on : 2017-07-25
Resolution : 1.58 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
Mogul	:	2022.3.0, CSD as543be (2022)
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

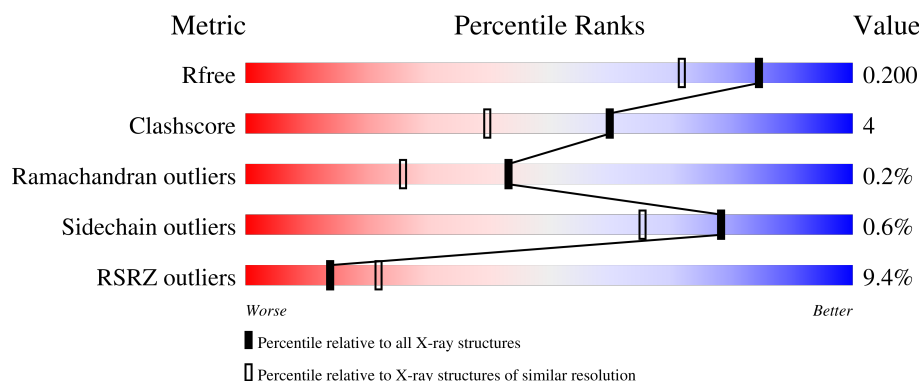
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.58 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	1094 (1.58-1.58)
Clashscore	190562	1105 (1.58-1.58)
Ramachandran outliers	187476	1082 (1.58-1.58)
Sidechain outliers	187428	1081 (1.58-1.58)
RSRZ outliers	180081	1094 (1.58-1.58)

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	223	5% 86% 7% 7%
1	B	223	7% 87% 6% 7%
1	C	223	9% 89% • 7%
1	D	223	14% 85% 8% 7%

2 Entry composition [i](#)

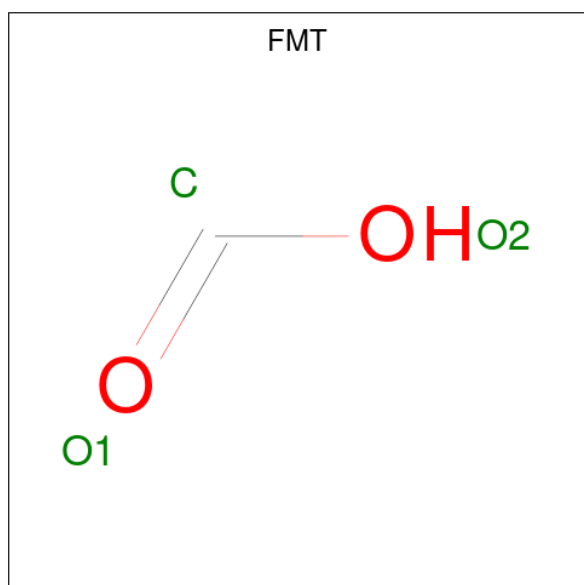
There are 3 unique types of molecules in this entry. The entry contains 13549 atoms, of which 6258 are hydrogens and 0 are deuteriums.

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 Engineered Chalcone Isomerase epR4.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	207	Total	C	H	N	O	S	0	0	0
			3116	996	1555	248	315	2			
1	B	207	Total	C	H	N	O	S	0	0	0
			3122	996	1561	248	315	2			
1	C	207	Total	C	H	N	O	S	0	0	0
			3131	996	1570	248	315	2			
1	D	207	Total	C	H	N	O	S	0	0	0
			3125	996	1564	248	315	2			

- Molecule 2 is FORMIC ACID (CCD ID: FMT) (formula: CH₂O₂).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	O	0	0
			5	1	2	2		
2	B	1	Total	C	H	O	0	0
			5	1	2	2		

Continued on next page...

Continued from previous page...

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	C	1	Total	C	H	O	0	0
			5	1	2	2		
2	D	1	Total	C	H	O	0	0
			5	1	2	2		

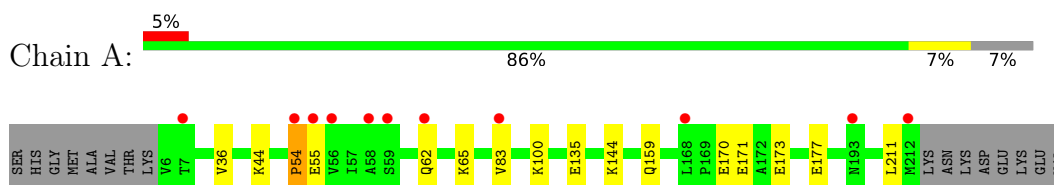
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	283	Total	O	0	0
			283	283		
3	B	276	Total	O	0	0
			276	276		
3	C	252	Total	O	0	0
			252	252		
3	D	224	Total	O	0	0
			224	224		

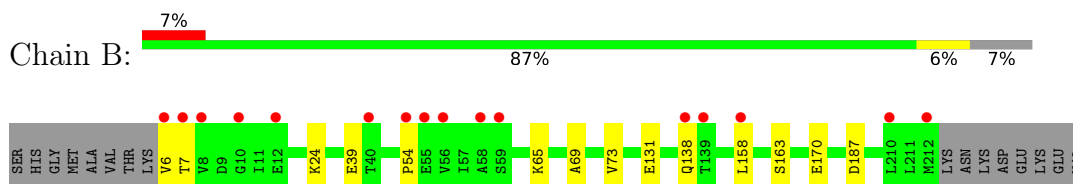
3 Residue-property plots

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.

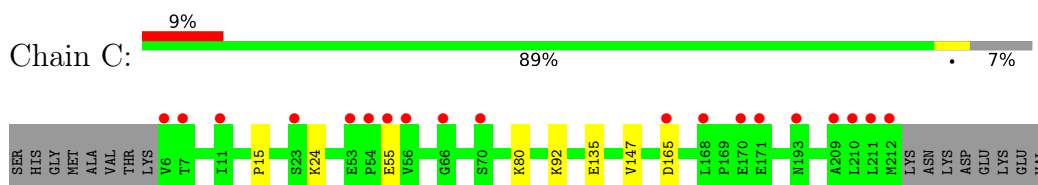
- Molecule 1: Engineered Chalcone Isomerase epR4



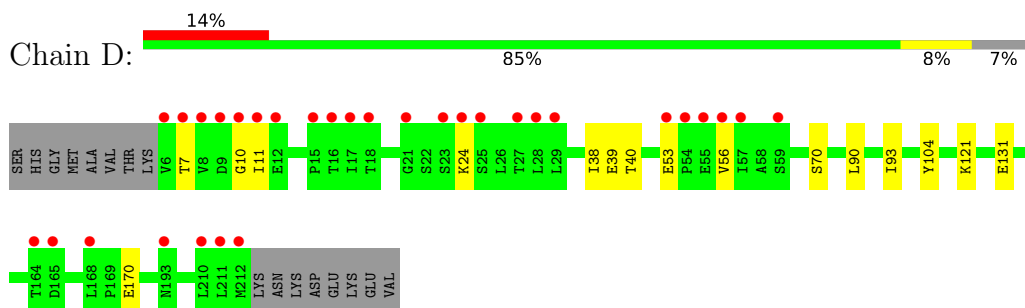
- Molecule 1: Engineered Chalcone Isomerase epR4



- Molecule 1: Engineered Chalcone Isomerase epR4



- Molecule 1: Engineered Chalcone Isomerase epR4



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	65.94Å 112.67Å 71.76Å 90.00° 117.37° 90.00°	Depositor
Resolution (Å)	58.57 – 1.58 58.57 – 1.58	Depositor EDS
% Data completeness (in resolution range)	99.7 (58.57-1.58) 99.7 (58.57-1.58)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.60 (at 1.58Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, R_{free}	0.170 , 0.193 0.173 , 0.200	Depositor DCC
R_{free} test set	1997 reflections (1.57%)	wwPDB-VP
Wilson B-factor (Å ²)	20.1	Xtriage
Anisotropy	0.353	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.40 , 47.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.017 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	13549	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.13% 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: FMT

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	0.40	0/1589	0.62	0/2155
1	B	0.41	0/1589	0.66	0/2155
1	C	0.40	0/1589	0.66	0/2155
1	D	0.40	0/1589	0.64	0/2155
All	All	0.40	0/6356	0.65	0/8620

There are no bond length outliers.

There are no bond angle outliers.

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	1561	1555	1570	15	0
1	B	1561	1561	1570	12	0
1	C	1561	1570	1570	10	0
1	D	1561	1564	1570	18	0
2	A	3	2	1	0	0
2	B	3	2	1	0	0
2	C	3	2	1	0	0
2	D	3	2	1	0	0
3	A	283	0	0	12	3

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	276	0	0	11	3
3	C	252	0	0	9	3
3	D	224	0	0	14	1
All	All	7291	6258	6284	54	5

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 (54) 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:D:53:GLU:HG2	3:D:406:HOH:O	1.54	1.04
1:A:144:LYS:NZ	3:A:402:HOH:O	1.93	0.98
1:B:170:GLU:OE1	3:B:401:HOH:O	1.81	0.98
1:A:173:GLU:OE1	3:A:401:HOH:O	1.88	0.90
1:B:7:THR:O	3:B:402:HOH:O	1.94	0.85
1:D:131:GLU:OE1	3:D:401:HOH:O	1.96	0.83
1:C:135:GLU:OE1	3:C:401:HOH:O	2.00	0.78
1:D:170:GLU:OE1	3:D:402:HOH:O	2.02	0.77
1:D:121:LYS:NZ	3:D:410:HOH:O	2.18	0.77
1:D:53:GLU:HG3	1:D:56:VAL:HB	1.67	0.76
1:D:7:THR:O	3:D:403:HOH:O	2.04	0.75
1:A:177:GLU:OE1	3:A:405:HOH:O	2.05	0.74
1:A:135:GLU:OE2	3:A:404:HOH:O	2.05	0.74
1:D:40:THR:OG1	3:D:404:HOH:O	2.05	0.74
1:B:187:ASP:OD1	3:B:403:HOH:O	2.06	0.73
1:D:39:GLU:OE1	3:D:405:HOH:O	2.07	0.72
1:C:24:LYS:NZ	3:C:403:HOH:O	2.23	0.70
1:D:24:LYS:NZ	3:D:413:HOH:O	2.27	0.68
1:D:135:GLU:OE1	3:D:407:HOH:O	2.15	0.64
1:D:10:GLY:O	3:D:408:HOH:O	2.15	0.64
1:C:92:LYS:NZ	3:C:405:HOH:O	2.32	0.63
1:D:70:SER:OG	3:D:409:HOH:O	2.16	0.62
1:B:131:GLU:OE1	3:B:404:HOH:O	2.16	0.62
1:B:65:LYS:NZ	3:B:410:HOH:O	2.34	0.58
1:A:62:GLN:NE2	3:A:409:HOH:O	2.37	0.58
1:B:24:LYS:NZ	3:B:414:HOH:O	2.38	0.56
1:A:159:GLN:NE2	3:A:403:HOH:O	2.03	0.55
1:A:65:LYS:NZ	1:A:211:LEU:O	2.40	0.55
1:C:55:GLU:HG2	3:C:574:HOH:O	2.07	0.54
1:B:187:ASP:CB	3:B:403:HOH:O	2.57	0.53

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:144:LYS:HE2	3:A:592:HOH:O	2.09	0.52
1:A:44:LYS:HE2	3:A:632:HOH:O	2.10	0.52
1:C:55:GLU:CD	3:C:406:HOH:O	2.53	0.51
1:A:171:GLU:HB3	3:A:406:HOH:O	2.11	0.50
1:B:187:ASP:HB2	3:B:403:HOH:O	2.12	0.49
1:D:53:GLU:HG3	1:D:56:VAL:CB	2.40	0.48
1:D:144:LYS:NZ	3:D:419:HOH:O	2.45	0.48
1:C:165:ASP:OD1	3:C:402:HOH:O	2.20	0.47
1:C:135:GLU:HG3	3:C:449:HOH:O	2.15	0.46
1:A:170:GLU:O	3:A:406:HOH:O	2.20	0.46
1:A:36:VAL:HG11	1:D:38:ILE:HG12	1.99	0.45
1:B:39:GLU:OE1	3:B:405:HOH:O	2.21	0.45
1:A:54:PRO:HG2	1:A:55:GLU:H	1.83	0.44
1:C:92:LYS:HE3	1:C:147:VAL:HG11	2.00	0.44
1:C:15:PRO:HD2	3:C:535:HOH:O	2.17	0.44
1:D:11:ILE:CG2	3:D:445:HOH:O	2.67	0.43
1:C:80:LYS:NZ	3:C:413:HOH:O	2.53	0.42
1:D:11:ILE:HG23	3:D:445:HOH:O	2.19	0.42
1:B:138:GLN:HB3	3:B:415:HOH:O	2.19	0.42
1:B:69:ALA:O	1:B:73:VAL:HG23	2.20	0.41
1:A:170:GLU:C	3:A:406:HOH:O	2.63	0.41
1:B:6:VAL:HG12	3:B:449:HOH:O	2.21	0.40
1:D:93:ILE:HD13	1:D:104:TYR:OH	2.21	0.40
1:A:100:LYS:NZ	3:A:413:HOH:O	2.46	0.40

All (5) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:B:626:HOH:O	3:C:431:HOH:O[1_454]	2.02	0.18
3:A:411:HOH:O	3:C:438:HOH:O[2_845]	2.16	0.04
3:A:618:HOH:O	3:C:595:HOH:O[2_845]	2.16	0.04
3:B:603:HOH:O	3:D:571:HOH:O[2_855]	2.16	0.04
3:A:656:HOH:O	3:B:652:HOH:O[2_845]	2.18	0.02

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	205/223 (92%)	203 (99%)	1 (0%)	1 (0%)	24	9
1	B	205/223 (92%)	200 (98%)	4 (2%)	1 (0%)	24	9
1	C	205/223 (92%)	204 (100%)	1 (0%)	0	100	100
1	D	205/223 (92%)	201 (98%)	4 (2%)	0	100	100
All	All	820/892 (92%)	808 (98%)	10 (1%)	2 (0%)	43	26

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	54	PRO
1	B	54	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	172/186 (92%)	171 (99%)	1 (1%)	78	65
1	B	172/186 (92%)	170 (99%)	2 (1%)	63	40
1	C	172/186 (92%)	172 (100%)	0	100	100
1	D	172/186 (92%)	171 (99%)	1 (1%)	78	65
All	All	688/744 (92%)	684 (99%)	4 (1%)	78	65

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	83	VAL
1	B	158	LEU
1	B	163	SER
1	D	90	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	60	HIS
1	C	60	HIS
1	D	60	HIS
1	D	159	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](#)

4 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
2	FMT	D	301	-	2,2,2	0.63	0	1,1,1	0.37	0
2	FMT	A	301	-	2,2,2	0.73	0	1,1,1	0.35	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
2	FMT	C	301	-	2,2,2	0.69	0	1,1,1	0.34	0
2	FMT	B	301	-	2,2,2	0.63	0	1,1,1	0.29	0

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

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	207/223 (92%)	0.11	11 (5%) 32 43	13, 24, 47, 67	0
1	B	207/223 (92%)	0.32	16 (7%) 19 29	14, 26, 52, 79	0
1	C	207/223 (92%)	0.34	19 (9%) 14 23	16, 28, 57, 72	0
1	D	207/223 (92%)	0.73	32 (15%) 5 9	17, 30, 63, 81	0
All	All	828/892 (92%)	0.38	78 (9%) 14 22	13, 27, 56, 81	0

All (78) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	6	VAL	7.1
1	B	6	VAL	7.0
1	A	55	GLU	5.5
1	A	56	VAL	5.2
1	A	59	SER	5.0
1	B	40	THR	4.7
1	D	7	THR	4.2
1	B	56	VAL	4.1
1	D	53	GLU	4.1
1	B	139	THR	4.0
1	D	56	VAL	3.9
1	D	210	LEU	3.9
1	C	165	ASP	3.8
1	D	25	SER	3.7
1	D	212	MET	3.7
1	D	16	THR	3.5
1	C	7	THR	3.5
1	D	10	GLY	3.4
1	B	7	THR	3.4
1	B	212	MET	3.4
1	C	210	LEU	3.4

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	D	168	LEU	3.4
1	C	212	MET	3.3
1	A	54	PRO	3.3
1	D	8	VAL	3.3
1	B	138	GLN	3.0
1	D	9	ASP	3.0
1	C	55	GLU	3.0
1	C	6	VAL	3.0
1	C	56	VAL	3.0
1	A	58	ALA	2.9
1	B	54	PRO	2.9
1	B	58	ALA	2.9
1	D	157	THR	2.9
1	A	212	MET	2.8
1	D	59	SER	2.8
1	B	210	LEU	2.8
1	D	27	THR	2.8
1	D	28	LEU	2.8
1	B	8	VAL	2.8
1	D	54	PRO	2.8
1	D	11	ILE	2.8
1	D	17	ILE	2.7
1	D	165	ASP	2.7
1	B	55	GLU	2.7
1	D	21	GLY	2.7
1	D	55	GLU	2.6
1	A	168	LEU	2.5
1	A	7	THR	2.5
1	C	193	ASN	2.5
1	B	10	GLY	2.5
1	D	18	THR	2.5
1	C	54	PRO	2.4
1	C	11	ILE	2.4
1	B	59	SER	2.4
1	B	12	GLU	2.4
1	C	70	SER	2.3
1	C	66	GLY	2.3
1	D	24	LYS	2.3
1	C	168	LEU	2.3
1	D	29	LEU	2.3
1	C	23	SER	2.3
1	D	193	ASN	2.2

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	RSRZ
1	D	211	LEU	2.2
1	D	57	ILE	2.2
1	C	209	ALA	2.1
1	A	62	GLN	2.1
1	C	211	LEU	2.1
1	D	12	GLU	2.1
1	C	171	GLU	2.1
1	D	15	PRO	2.1
1	B	158	LEU	2.1
1	D	164	THR	2.0
1	C	53	GLU	2.0
1	D	23	SER	2.0
1	C	170	GLU	2.0
1	A	83	VAL	2.0
1	A	193	ASN	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](#)

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
2	FMT	C	301	3/3	0.96	0.05	13,15,17,18	0
2	FMT	B	301	3/3	0.97	0.05	14,16,17,19	0
2	FMT	D	301	3/3	0.97	0.05	16,17,20,21	0
2	FMT	A	301	3/3	0.98	0.04	15,16,18,19	0

6.5 Other polymers [i](#)

There are no such residues in this entry.