wwPDB X-ray Structure Validation Summary Report (i)

Oct 30, 2023 – 05:43 PM JST

PDB ID	:	4XDW
Title	:	Crystal Structure of the L74F/M78V/I80V/L114F mutant of LEH
Authors	:	Kong, X.D.; Sun, Z.; Lonsdale, R.; Xu, J.H.; Reetz, M.T.; Zhou, J.
Deposited on	:	2014-12-20
Resolution	:	2.05 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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 (i) 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 (1)) were used in the production of this report:

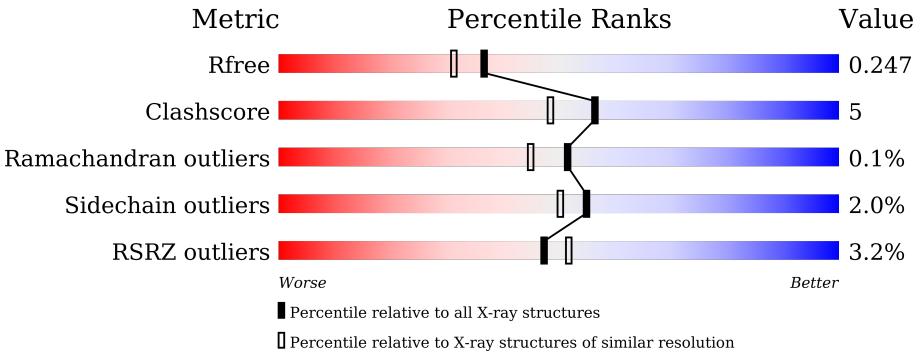
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.05 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}	130704	1692 (2.04-2.04)
Clashscore	141614	1773 (2.04-2.04)
Ramachandran outliers	138981	1752 (2.04-2.04)
Sidechain outliers	138945	1752 (2.04-2.04)
RSRZ outliers	127900	1672 (2.04-2.04)

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 <=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	155	83% 10% • 6%
1	B	155	% 85% 8% • 6%
1	C	155	% 83% 10% 6%
1	D	155	% 85% 6% • 6%
1	E	155	3% 84% 6% • 8%
1	F	155	11% 74% 14% • 12%

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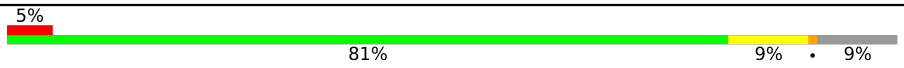
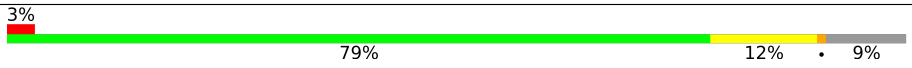
Mol	Chain	Length	Quality of chain
1	G	155	
1	H	155	

2 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 10006 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 Limonene-1,2-epoxide hydrolase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	145	Total	C	N	O	S	0	1	0
			1147	735	184	225	3			
1	E	142	Total	C	N	O	S	0	1	0
			1121	720	177	221	3			
1	G	141	Total	C	N	O	S	0	0	0
			1106	707	176	220	3			
1	B	145	Total	C	N	O	S	0	0	0
			1136	726	183	224	3			
1	F	137	Total	C	N	O	S	0	0	0
			1073	686	172	212	3			
1	H	141	Total	C	N	O	S	0	0	0
			1106	707	176	220	3			
1	C	145	Total	C	N	O	S	0	1	0
			1147	735	184	225	3			
1	D	145	Total	C	N	O	S	0	0	0
			1136	726	183	224	3			

There are 112 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-5	MET	-	initiating methionine	UNP Q9ZAG3
A	-4	HIS	-	expression tag	UNP Q9ZAG3
A	-3	HIS	-	expression tag	UNP Q9ZAG3
A	-2	HIS	-	expression tag	UNP Q9ZAG3
A	-1	HIS	-	expression tag	UNP Q9ZAG3
A	0	HIS	-	expression tag	UNP Q9ZAG3
A	1	HIS	-	expression tag	UNP Q9ZAG3
A	2	THR	-	expression tag	UNP Q9ZAG3
A	3	SER	-	expression tag	UNP Q9ZAG3
A	4	LEU	-	expression tag	UNP Q9ZAG3
A	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
A	78	VAL	MET	engineered mutation	UNP Q9ZAG3
A	80	VAL	ILE	engineered mutation	UNP Q9ZAG3

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Chain	Residue	Modelled	Actual	Comment	Reference
A	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
E	-5	MET	-	initiating methionine	UNP Q9ZAG3
E	-4	HIS	-	expression tag	UNP Q9ZAG3
E	-3	HIS	-	expression tag	UNP Q9ZAG3
E	-2	HIS	-	expression tag	UNP Q9ZAG3
E	-1	HIS	-	expression tag	UNP Q9ZAG3
E	0	HIS	-	expression tag	UNP Q9ZAG3
E	1	HIS	-	expression tag	UNP Q9ZAG3
E	2	THR	-	expression tag	UNP Q9ZAG3
E	3	SER	-	expression tag	UNP Q9ZAG3
E	4	LEU	-	expression tag	UNP Q9ZAG3
E	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
E	78	VAL	MET	engineered mutation	UNP Q9ZAG3
E	80	VAL	ILE	engineered mutation	UNP Q9ZAG3
E	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
G	-5	MET	-	initiating methionine	UNP Q9ZAG3
G	-4	HIS	-	expression tag	UNP Q9ZAG3
G	-3	HIS	-	expression tag	UNP Q9ZAG3
G	-2	HIS	-	expression tag	UNP Q9ZAG3
G	-1	HIS	-	expression tag	UNP Q9ZAG3
G	0	HIS	-	expression tag	UNP Q9ZAG3
G	1	HIS	-	expression tag	UNP Q9ZAG3
G	2	THR	-	expression tag	UNP Q9ZAG3
G	3	SER	-	expression tag	UNP Q9ZAG3
G	4	LEU	-	expression tag	UNP Q9ZAG3
G	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
G	78	VAL	MET	engineered mutation	UNP Q9ZAG3
G	80	VAL	ILE	engineered mutation	UNP Q9ZAG3
G	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
B	-5	MET	-	initiating methionine	UNP Q9ZAG3
B	-4	HIS	-	expression tag	UNP Q9ZAG3
B	-3	HIS	-	expression tag	UNP Q9ZAG3
B	-2	HIS	-	expression tag	UNP Q9ZAG3
B	-1	HIS	-	expression tag	UNP Q9ZAG3
B	0	HIS	-	expression tag	UNP Q9ZAG3
B	1	HIS	-	expression tag	UNP Q9ZAG3
B	2	THR	-	expression tag	UNP Q9ZAG3
B	3	SER	-	expression tag	UNP Q9ZAG3
B	4	LEU	-	expression tag	UNP Q9ZAG3
B	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
B	78	VAL	MET	engineered mutation	UNP Q9ZAG3
B	80	VAL	ILE	engineered mutation	UNP Q9ZAG3

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Chain	Residue	Modelled	Actual	Comment	Reference
B	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
F	-5	MET	-	initiating methionine	UNP Q9ZAG3
F	-4	HIS	-	expression tag	UNP Q9ZAG3
F	-3	HIS	-	expression tag	UNP Q9ZAG3
F	-2	HIS	-	expression tag	UNP Q9ZAG3
F	-1	HIS	-	expression tag	UNP Q9ZAG3
F	0	HIS	-	expression tag	UNP Q9ZAG3
F	1	HIS	-	expression tag	UNP Q9ZAG3
F	2	THR	-	expression tag	UNP Q9ZAG3
F	3	SER	-	expression tag	UNP Q9ZAG3
F	4	LEU	-	expression tag	UNP Q9ZAG3
F	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
F	78	VAL	MET	engineered mutation	UNP Q9ZAG3
F	80	VAL	ILE	engineered mutation	UNP Q9ZAG3
F	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
H	-5	MET	-	initiating methionine	UNP Q9ZAG3
H	-4	HIS	-	expression tag	UNP Q9ZAG3
H	-3	HIS	-	expression tag	UNP Q9ZAG3
H	-2	HIS	-	expression tag	UNP Q9ZAG3
H	-1	HIS	-	expression tag	UNP Q9ZAG3
H	0	HIS	-	expression tag	UNP Q9ZAG3
H	1	HIS	-	expression tag	UNP Q9ZAG3
H	2	THR	-	expression tag	UNP Q9ZAG3
H	3	SER	-	expression tag	UNP Q9ZAG3
H	4	LEU	-	expression tag	UNP Q9ZAG3
H	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
H	78	VAL	MET	engineered mutation	UNP Q9ZAG3
H	80	VAL	ILE	engineered mutation	UNP Q9ZAG3
H	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
C	-5	MET	-	initiating methionine	UNP Q9ZAG3
C	-4	HIS	-	expression tag	UNP Q9ZAG3
C	-3	HIS	-	expression tag	UNP Q9ZAG3
C	-2	HIS	-	expression tag	UNP Q9ZAG3
C	-1	HIS	-	expression tag	UNP Q9ZAG3
C	0	HIS	-	expression tag	UNP Q9ZAG3
C	1	HIS	-	expression tag	UNP Q9ZAG3
C	2	THR	-	expression tag	UNP Q9ZAG3
C	3	SER	-	expression tag	UNP Q9ZAG3
C	4	LEU	-	expression tag	UNP Q9ZAG3
C	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
C	78	VAL	MET	engineered mutation	UNP Q9ZAG3
C	80	VAL	ILE	engineered mutation	UNP Q9ZAG3

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Chain	Residue	Modelled	Actual	Comment	Reference
C	114	PHE	LEU	engineered mutation	UNP Q9ZAG3
D	-5	MET	-	initiating methionine	UNP Q9ZAG3
D	-4	HIS	-	expression tag	UNP Q9ZAG3
D	-3	HIS	-	expression tag	UNP Q9ZAG3
D	-2	HIS	-	expression tag	UNP Q9ZAG3
D	-1	HIS	-	expression tag	UNP Q9ZAG3
D	0	HIS	-	expression tag	UNP Q9ZAG3
D	1	HIS	-	expression tag	UNP Q9ZAG3
D	2	THR	-	expression tag	UNP Q9ZAG3
D	3	SER	-	expression tag	UNP Q9ZAG3
D	4	LEU	-	expression tag	UNP Q9ZAG3
D	74	PHE	LEU	engineered mutation	UNP Q9ZAG3
D	78	VAL	MET	engineered mutation	UNP Q9ZAG3
D	80	VAL	ILE	engineered mutation	UNP Q9ZAG3
D	114	PHE	LEU	engineered mutation	UNP Q9ZAG3

- Molecule 2 is water.

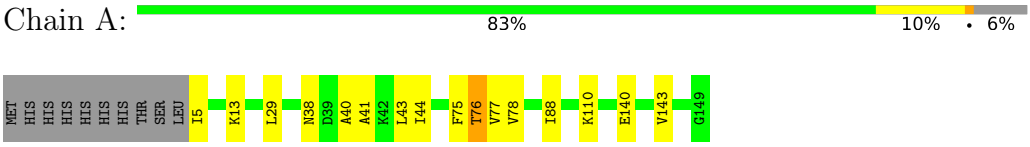
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	176	Total O 176 176	0	0
2	E	85	Total O 85 85	0	0
2	G	107	Total O 107 107	0	0
2	B	151	Total O 151 151	0	0
2	F	77	Total O 77 77	0	0
2	H	93	Total O 93 93	0	0
2	C	177	Total O 177 177	0	0
2	D	168	Total O 168 168	0	0

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.

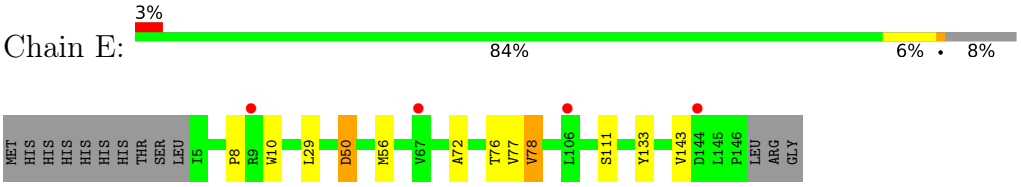
• Molecule 1: Limonene-1,2-epoxide hydrolase

Chain A:



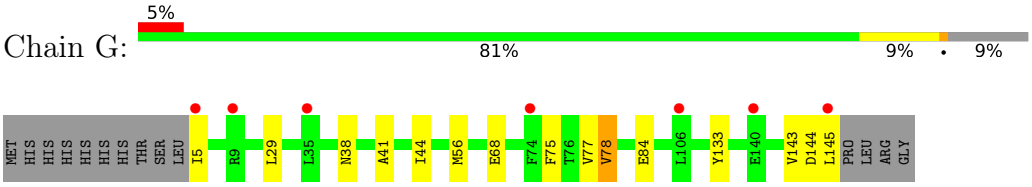
• Molecule 1: Limonene-1,2-epoxide hydrolase

Chain E:



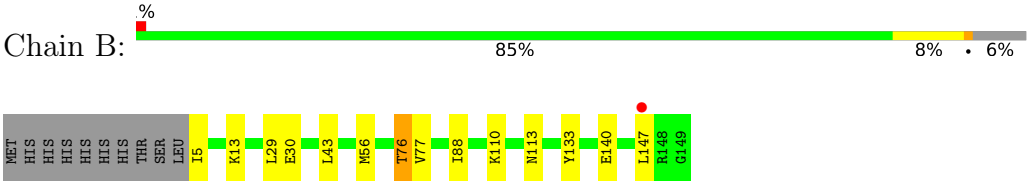
• Molecule 1: Limonene-1,2-epoxide hydrolase

Chain G:



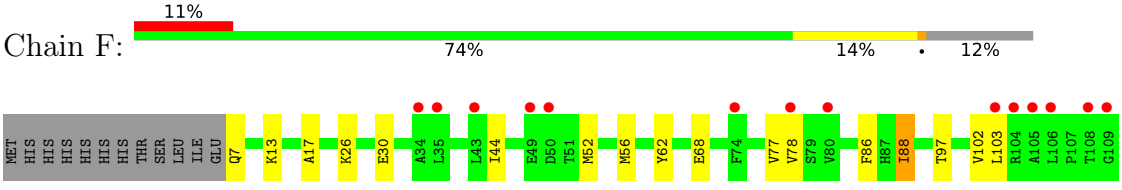
• Molecule 1: Limonene-1,2-epoxide hydrolase

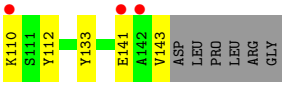
Chain B:



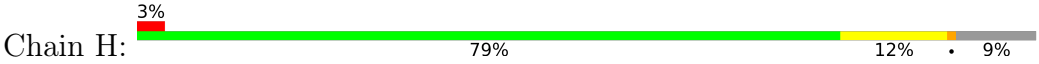
• Molecule 1: Limonene-1,2-epoxide hydrolase

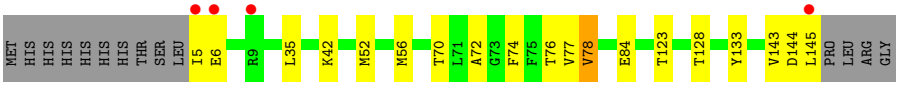
Chain F:



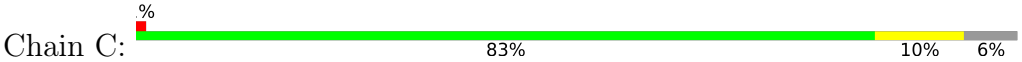


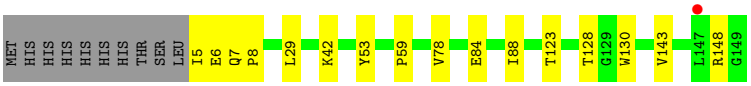
• Molecule 1: Limonene-1,2-epoxide hydrolase



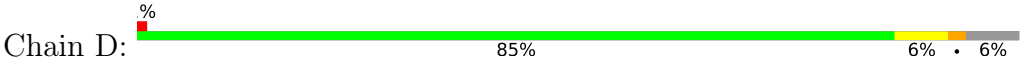


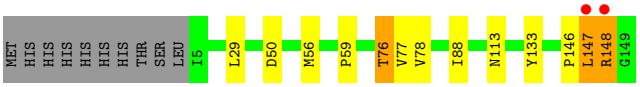
• Molecule 1: Limonene-1,2-epoxide hydrolase





• Molecule 1: Limonene-1,2-epoxide hydrolase





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	104.27Å 60.90Å 119.05Å 90.00° 90.57° 90.00°	Depositor
Resolution (Å)	31.75 – 2.05 31.75 – 2.05	Depositor EDS
% Data completeness (in resolution range)	97.4 (31.75-2.05) 94.9 (31.75-2.05)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.28 (at 2.05Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.202 , 0.245 0.205 , 0.247	Depositor DCC
R_{free} test set	4637 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å^2)	35.1	Xtriage
Anisotropy	0.187	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 34.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.267 for h,-k,-l	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	10006	wwPDB-VP
Average B, all atoms (Å^2)	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 60.62 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 1.4810e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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	0.46	0/1174	0.57	0/1596
1	B	0.44	0/1162	0.56	0/1580
1	C	0.48	0/1174	0.61	0/1596
1	D	0.46	0/1162	0.57	0/1580
1	E	0.36	0/1151	0.53	0/1566
1	F	0.36	0/1098	0.54	0/1493
1	G	0.38	0/1131	0.54	0/1538
1	H	0.38	0/1131	0.55	0/1538
All	All	0.42	0/9183	0.56	0/12487

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

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	1147	0	1101	11	0
1	B	1136	0	1093	9	0
1	C	1147	0	1101	12	0
1	D	1136	0	1093	10	0
1	E	1121	0	1075	6	0
1	F	1073	0	1027	17	0
1	G	1106	0	1059	9	0
1	H	1106	0	1059	14	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	A	176	0	0	7	0
2	B	151	0	0	4	1
2	C	177	0	0	2	1
2	D	168	0	0	3	0
2	E	85	0	0	1	0
2	F	77	0	0	8	0
2	G	107	0	0	2	0
2	H	93	0	0	4	0
All	All	10006	0	8608	88	1

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 5.

The worst 5 of 88 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:40:ALA:O	2:A:356:HOH:O	1.96	0.83
1:F:112:TYR:O	2:F:256:HOH:O	2.00	0.79
1:F:88:ILE:HD12	1:F:97:THR:HG22	1.71	0.73
1:A:76:THR:HG22	1:A:77:VAL:HG13	1.70	0.72
1:D:148:ARG:NH2	2:D:201:HOH:O	2.24	0.70

All (1) 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)
2:B:216:HOH:O	2:C:221:HOH:O[2_555]	2.04	0.16

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	144/155 (93%)	142 (99%)	2 (1%)	0	100	100
1	B	143/155 (92%)	142 (99%)	1 (1%)	0	100	100
1	C	144/155 (93%)	142 (99%)	2 (1%)	0	100	100
1	D	143/155 (92%)	141 (99%)	2 (1%)	0	100	100
1	E	141/155 (91%)	140 (99%)	1 (1%)	0	100	100
1	F	135/155 (87%)	134 (99%)	1 (1%)	0	100	100
1	G	139/155 (90%)	138 (99%)	0	1 (1%)	22	12
1	H	139/155 (90%)	138 (99%)	1 (1%)	0	100	100
All	All	1128/1240 (91%)	1117 (99%)	10 (1%)	1 (0%)	51	45

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	G	144	ASP

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	121/130 (93%)	118 (98%)	3 (2%)	47	40
1	B	120/130 (92%)	118 (98%)	2 (2%)	60	57
1	C	121/130 (93%)	121 (100%)	0	100	100
1	D	120/130 (92%)	117 (98%)	3 (2%)	47	40
1	E	119/130 (92%)	115 (97%)	4 (3%)	37	30
1	F	113/130 (87%)	111 (98%)	2 (2%)	59	55
1	G	117/130 (90%)	115 (98%)	2 (2%)	60	57
1	H	117/130 (90%)	114 (97%)	3 (3%)	46	39
All	All	948/1040 (91%)	929 (98%)	19 (2%)	55	50

5 of 19 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	H	78	VAL
1	D	147	LEU
1	D	148	ARG
1	D	76	THR
1	G	78	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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 (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, 95^{th} 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	145/155 (93%)	-0.06	0 100 100	18, 26, 40, 59	0
1	B	145/155 (93%)	-0.05	1 (0%) 87 89	17, 26, 41, 59	0
1	C	145/155 (93%)	-0.01	1 (0%) 87 89	15, 24, 41, 60	0
1	D	145/155 (93%)	-0.01	2 (1%) 75 78	14, 23, 41, 56	0
1	E	142/155 (91%)	0.22	4 (2%) 53 58	28, 44, 61, 70	0
1	F	137/155 (88%)	0.61	17 (12%) 4 3	27, 50, 76, 85	0
1	G	141/155 (90%)	0.16	7 (4%) 28 31	23, 38, 56, 73	0
1	H	141/155 (90%)	0.04	4 (2%) 53 58	23, 38, 54, 75	0
All	All	1141/1240 (92%)	0.11	36 (3%) 47 52	14, 32, 61, 85	0

The worst 5 of 36 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	F	35	LEU	6.3
1	F	74	PHE	5.0
1	F	109	GLY	4.8
1	F	104	ARG	4.0
1	F	103	LEU	3.9

6.2 Non-standard residues in protein, DNA, RNA chains

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates

There are no monosaccharides in this entry.

6.4 Ligands

There are no ligands in this entry.

6.5 Other polymers

There are no such residues in this entry.