



Full wwPDB X-ray Structure Validation Report ⓘ

Oct 4, 2021 – 02:22 PM EDT

PDB ID : 6UD1
Title : Spectroscopic and structural characterization of a genetically encoded direct sensor for protein-ligand interactions
Authors : Mills, J.H.; Gleason, P.R.; Simmons, C.R.; Henderson, J.N.; Kartchner, B.K.
Deposited on : 2019-09-18
Resolution : 1.55 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 following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.23.2
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) : 2.23.2

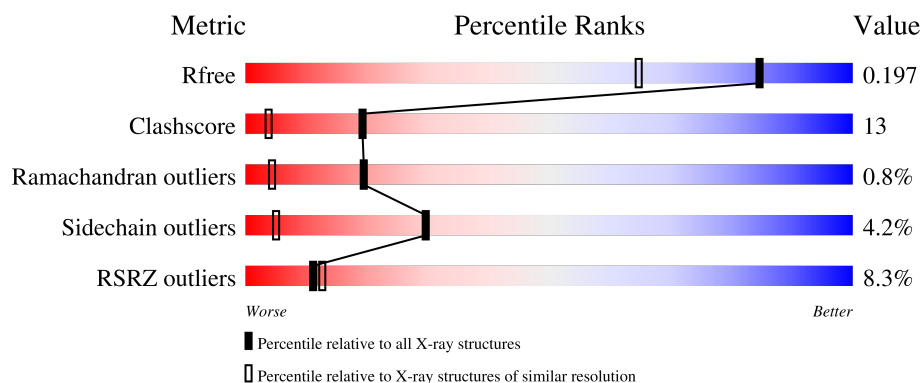
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.55 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	1483 (1.56-1.56)
Clashscore	141614	1529 (1.56-1.56)
Ramachandran outliers	138981	1498 (1.56-1.56)
Sidechain outliers	138945	1495 (1.56-1.56)
RSRZ outliers	127900	1465 (1.56-1.56)

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	136	<div> <div>7%</div> <div> <div></div> <div>71%</div> <div>14%</div> <div>••</div> <div>12%</div> </div> </div>
1	B	136	<div> <div>7%</div> <div> <div></div> <div>73%</div> <div>13%</div> <div>••</div> <div>10%</div> </div> </div>

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2149 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 Streptavidin.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
1	A	120	Total	C	N	O	0	17	0
			996	633	170	193			
1	B	122	Total	C	N	O	0	12	0
			980	620	168	192			

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	12	MET	-	initiating methionine	UNP P22629
A	120	DV7	TRP	conflict	UNP P22629
A	140	LEU	-	expression tag	UNP P22629
A	141	GLU	-	expression tag	UNP P22629
A	142	HIS	-	expression tag	UNP P22629
A	143	HIS	-	expression tag	UNP P22629
A	144	HIS	-	expression tag	UNP P22629
A	145	HIS	-	expression tag	UNP P22629
A	146	HIS	-	expression tag	UNP P22629
A	147	HIS	-	expression tag	UNP P22629
B	12	MET	-	initiating methionine	UNP P22629
B	120	DV7	TRP	conflict	UNP P22629
B	140	LEU	-	expression tag	UNP P22629
B	141	GLU	-	expression tag	UNP P22629
B	142	HIS	-	expression tag	UNP P22629
B	143	HIS	-	expression tag	UNP P22629
B	144	HIS	-	expression tag	UNP P22629
B	145	HIS	-	expression tag	UNP P22629
B	146	HIS	-	expression tag	UNP P22629
B	147	HIS	-	expression tag	UNP P22629

- Molecule 2 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

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

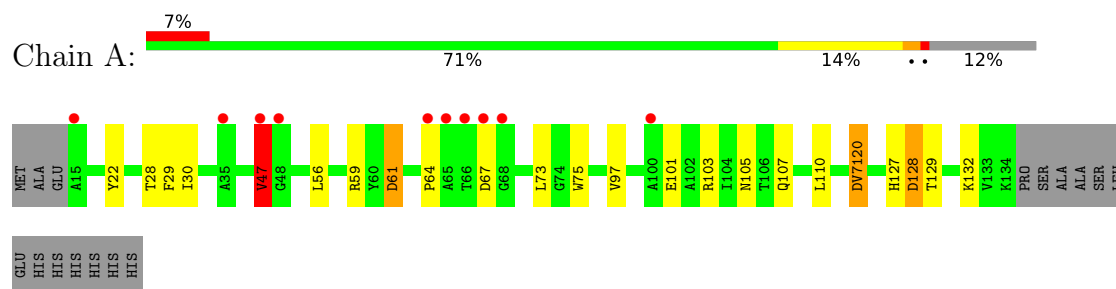
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	86	Total 86	O 86	0	0
3	B	85	Total 85	O 85	0	0

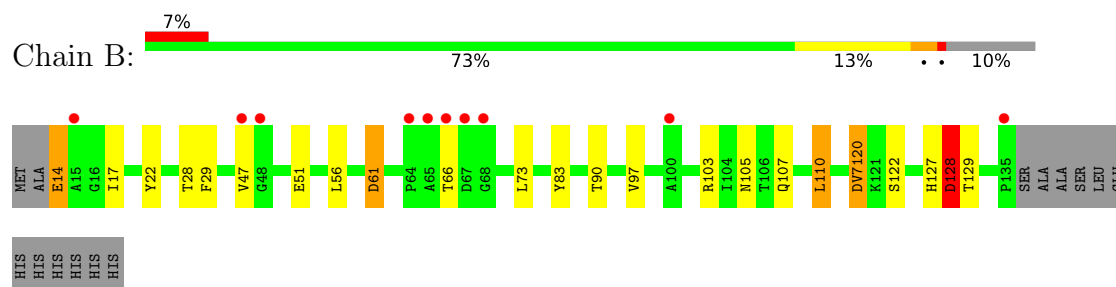
3 Residue-property plots [i](#)

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: Streptavidin



• Molecule 1: Streptavidin



4 Data and refinement statistics

Property	Value	Source
Space group	I 41	Depositor
Cell constants a, b, c, α , β , γ	57.35Å 57.35Å 172.32Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	86.16 – 1.55 43.08 – 1.55	Depositor EDS
% Data completeness (in resolution range)	99.8 (86.16-1.55) 99.9 (43.08-1.55)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.33 (at 1.55Å)	Xtriage
Refinement program	REFMAC 5.8.0189	Depositor
R, R_{free}	0.166 , 0.192 0.176 , 0.197	Depositor DCC
R_{free} test set	1968 reflections (4.92%)	wwPDB-VP
Wilson B-factor (Å ²)	18.3	Xtriage
Anisotropy	0.065	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 52.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	0.487 for -h,k,-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	2149	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 12.26% 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

Bond lengths and bond angles in the following residue types are not validated in this section: DV7, CL

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	1.28	1/1048 (0.1%)	1.24	2/1428 (0.1%)
1	B	1.31	1/1021 (0.1%)	1.23	1/1394 (0.1%)
All	All	1.30	2/2069 (0.1%)	1.23	3/2822 (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	B	0	2

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	122	SER	CB-OG	5.84	1.49	1.42
1	A	75	TRP	NE1-CE2	-5.25	1.30	1.37

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	59	ARG	NE-CZ-NH2	-6.74	116.93	120.30
1	B	128	ASP	CB-CG-OD2	5.21	122.99	118.30
1	A	73	LEU	CB-CG-CD1	5.08	119.63	111.00

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	14	GLU	Peptide
1	B	66	THR	Peptide

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	996	0	964	24	1
1	B	980	0	920	26	1
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	86	0	0	12	1
3	B	85	0	0	11	1
All	All	2149	0	1884	50	3

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 13.

All (50) 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:B:107[B]:GLN:NE2	3:B:302:HOH:O	1.84	1.11
1:A:107[B]:GLN:NE2	3:A:303:HOH:O	1.90	1.04
1:B:29[B]:PHE:CE1	1:B:56:LEU:HD11	2.02	0.94
1:A:29[B]:PHE:CE1	1:A:56:LEU:HD11	2.10	0.86
1:A:127[A]:HIS:ND1	3:A:304:HOH:O	2.08	0.85
1:B:127[A]:HIS:ND1	3:B:303:HOH:O	2.10	0.84
1:B:29[B]:PHE:CD1	1:B:56:LEU:HD11	2.19	0.76
1:B:110[B]:LEU:HD12	3:B:344:HOH:O	1.87	0.74
1:A:64:PRO:HD3	3:A:335:HOH:O	1.89	0.71
1:B:29[B]:PHE:HE1	1:B:56:LEU:HD11	1.57	0.69
1:B:61[B]:ASP:OD2	3:B:301:HOH:O	0.69	0.69
1:A:30:ILE:HD12	3:A:370:HOH:O	1.93	0.68
1:B:22:TYR:HD1	1:B:28[B]:THR:HG22	1.59	0.67
1:A:22:TYR:CD1	1:A:28[B]:THR:HG22	2.30	0.67
1:A:29[B]:PHE:CD1	1:A:56:LEU:CD1	2.78	0.66
1:B:29[B]:PHE:CD1	1:B:56:LEU:CD1	2.78	0.65

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:29[B]:PHE:CD1	1:A:56:LEU:HD11	2.32	0.64
1:A:30:ILE:CD1	3:A:370:HOH:O	2.46	0.64
1:A:22:TYR:HD1	1:A:28[B]:THR:HG22	1.63	0.63
1:B:22:TYR:CD1	1:B:28[B]:THR:HG22	2.34	0.62
1:A:29[B]:PHE:CE1	1:A:56:LEU:CD1	2.82	0.60
1:B:61[A]:ASP:HB2	3:B:301:HOH:O	2.02	0.59
1:B:29[B]:PHE:HD1	1:B:56:LEU:CD1	2.18	0.56
1:B:97:VAL:HG23	3:B:315:HOH:O	2.05	0.54
1:B:29[B]:PHE:CE1	1:B:56:LEU:CD1	2.84	0.54
1:A:29[B]:PHE:HE1	1:A:56:LEU:HD11	1.71	0.53
1:A:47:VAL:N	3:A:308:HOH:O	2.42	0.52
1:A:132[B]:LYS:NZ	3:A:302:HOH:O	1.87	0.51
1:B:51:GLU:HG2	1:B:83:TYR:CD1	2.46	0.51
1:A:97:VAL:HG23	3:A:310:HOH:O	2.11	0.51
1:A:29[B]:PHE:CD1	1:A:56:LEU:HD13	2.46	0.50
1:A:29[B]:PHE:HD1	1:A:56:LEU:HD13	1.75	0.50
1:A:29[B]:PHE:HD1	1:A:56:LEU:CD1	2.22	0.49
1:B:105:ASN:ND2	1:B:129:THR:HG23	2.28	0.49
1:B:47:VAL:HA	3:B:309:HOH:O	2.13	0.48
1:A:107[A]:GLN:HE21	1:A:127[A]:HIS:HB3	1.79	0.48
1:A:61[A]:ASP:HB2	3:A:301:HOH:O	2.13	0.47
1:B:47:VAL:N	3:B:309:HOH:O	2.48	0.47
1:A:47:VAL:HG11	3:A:384:HOH:O	2.15	0.46
1:A:103[B]:ARG:NH1	3:A:311:HOH:O	2.45	0.46
1:B:103[B]:ARG:NH1	3:B:304:HOH:O	2.34	0.46
1:A:105[A]:ASN:ND2	1:A:129:THR:HG23	2.33	0.43
1:B:14:GLU:CB	1:B:17:ILE:H	2.31	0.43
1:B:90:THR:OG1	1:B:110[A]:LEU:HG	2.18	0.43
1:B:47:VAL:CA	3:B:309:HOH:O	2.67	0.43
1:B:73:LEU:C	1:B:73:LEU:HD12	2.38	0.43
1:B:127[A]:HIS:CE1	3:B:303:HOH:O	2.67	0.42
3:A:333:HOH:O	1:B:107[B]:GLN:HG3	2.19	0.42
1:B:107[A]:GLN:HE21	1:B:127[A]:HIS:HB3	1.85	0.41

All (3) 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:A:315:HOH:O	3:B:350:HOH:O[6_455]	1.96	0.24
1:A:120:DV7:OI	1:A:128:ASP:OD2[6_455]	2.15	0.05
1:B:120:DV7:OI	1:B:128:ASP:OD2[6_455]	2.18	0.02

5.3 Torsion angles

5.3.1 Protein backbone

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	135/136 (99%)	129 (96%)	4 (3%)	2 (2%)	10	1
1	B	132/136 (97%)	127 (96%)	5 (4%)	0	100	100
All	All	267/272 (98%)	256 (96%)	9 (3%)	2 (1%)	19	5

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	67	ASP
1	A	47	VAL

5.3.2 Protein sidechains

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	102/100 (102%)	96 (94%)	6 (6%)	19	2
1	B	97/100 (97%)	91 (94%)	6 (6%)	18	2
All	All	199/200 (100%)	187 (94%)	12 (6%)	30	2

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	47	VAL
1	A	61[A]	ASP
1	A	61[B]	ASP
1	A	61[C]	ASP

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Mol	Chain	Res	Type
1	A	101	GLU
1	A	128	ASP
1	B	61[A]	ASP
1	B	61[B]	ASP
1	B	61[C]	ASP
1	B	110[A]	LEU
1	B	110[B]	LEU
1	B	128	ASP

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	118	ASN
1	B	118	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

2 non-standard protein/DNA/RNA residues 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
1	DV7	A	120	1	16,19,20	1.61	2 (12%)	18,26,28	1.40	3 (16%)
1	DV7	B	120	1	16,19,20	1.76	2 (12%)	18,26,28	1.41	2 (11%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
1	DV7	A	120	1	-	0/6/7/9	0/2/2/2
1	DV7	B	120	1	-	0/6/7/9	0/2/2/2

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	120	DV7	CE1-CZ1	4.35	1.46	1.37
1	A	120	DV7	CE1-CZ1	4.08	1.45	1.37
1	B	120	DV7	CH1-CT	3.85	1.44	1.37
1	A	120	DV7	CH1-CT	3.46	1.43	1.37

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	120	DV7	CB-CG-CD	-3.39	102.92	112.05
1	A	120	DV7	CZ3-CE2-CD	2.89	127.34	122.55
1	B	120	DV7	CB-CG-CD	-2.74	104.67	112.05
1	B	120	DV7	CZ3-CE2-CD	2.35	126.45	122.55
1	A	120	DV7	CH2-CT-CH1	-2.11	117.69	120.39

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	A	120	DV7	0	1
1	B	120	DV7	0	1

5.5 Carbohydrates [i](#)

There are no monosaccharides 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

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

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	119/136 (87%)	0.41	10 (8%) 11 12	12, 20, 58, 83	0
1	B	121/136 (88%)	0.47	10 (8%) 11 12	12, 21, 58, 79	0
All	All	240/272 (88%)	0.44	20 (8%) 11 12	12, 21, 59, 83	0

All (20) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	15	ALA	9.0
1	A	15	ALA	6.2
1	A	100	ALA	5.5
1	B	100	ALA	4.8
1	A	64	PRO	4.8
1	B	47	VAL	4.6
1	B	64	PRO	4.5
1	B	65	ALA	4.5
1	A	47	VAL	4.4
1	B	48	GLY	3.9
1	B	68	GLY	3.7
1	A	65	ALA	3.4
1	A	68	GLY	3.4
1	B	135	PRO	3.3
1	A	48	GLY	3.2
1	B	67	ASP	2.4
1	B	66	THR	2.3
1	A	66	THR	2.3
1	A	67	ASP	2.2
1	A	35	ALA	2.1

6.2 Non-standard residues in protein, DNA, RNA chains [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(\AA^2)	Q<0.9
1	DV7	A	120	18/19	0.83	0.15	28,55,62,64	0
1	DV7	B	120	18/19	0.83	0.16	28,52,61,64	0

6.3 Carbohydrates [i](#)

There are no monosaccharides 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(\AA^2)	Q<0.9
2	CL	A	201	1/1	0.97	0.06	29,29,29,29	0
2	CL	B	201	1/1	0.97	0.07	28,28,28,28	0

6.5 Other polymers [i](#)

There are no such residues in this entry.