



Full wwPDB NMR Structure Validation Report ⓘ

Apr 27, 2016 – 01:00 AM BST

PDB ID : 2LE1
Title : Solution NMR Structure of Tfu_2981 from Thermobifida fusca, Northeast Structural Genomics Consortium Target Tfr85A
Authors : Pulavarti, S.V.S.R.K.; Eletsky, A.; Mills, J.L.; Sukumaran, D.K.; Wang, D.; Ciccocanti, C.; Hamilton, K.; Rost, B.; Acton, T.B.; Xiao, R.; Everett, J.K.; Lee, H.; Prestegard, J.H.; Montelione, G.T.; Szyperski, T.; Northeast Structural Genomics Consortium (NESG)
Deposited on : 2011-06-03

This is a Full wwPDB NMR Structure Validation Report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
<http://wwpdb.org/validation/2016/NMRValidationReportHelp>
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:

Cyrange : Kirchner and Güntert (2011)
NmrClust : Kelley et al. (1996)
MolProbity : 4.02b-467
Mogul : unknown
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI : v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV : Wang et al. (2010)
ShiftChecker : rb-20027457
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20027457

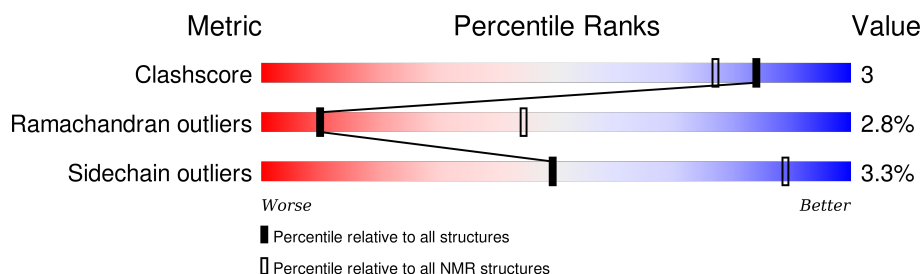
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment is 89%.

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)	NMR archive (#Entries)
Clashscore	114402	11133
Ramachandran outliers	111179	9975
Sidechain outliers	111093	9958

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and 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 $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	151	 87% 6% 7%

2 Ensemble composition and analysis

This entry contains 20 models. Model 7 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *lowest energy*.

The following residues are included in the computation of the global validation metrics.

Well-defined (core) protein residues			
Well-defined core	Residue range (total)	Backbone RMSD (Å)	Medoid model
1	A:2-A:142 (141)	0.45	7

Ill-defined regions of proteins are excluded from the global statistics.

Ligands and non-protein polymers are included in the analysis.

The models can be grouped into 5 clusters. No single-model clusters were found.

Cluster number	Models
1	1, 5, 7, 8, 12, 14, 16, 17, 18, 20
2	2, 4, 10
3	9, 11, 19
4	3, 6
5	13, 15

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 2338 atoms, of which 1150 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Uncharacterized protein.

Mol	Chain	Residues	Atoms						Trace
1	A	151	Total	C	H	N	O	S	0
			2338	742	1150	224	217	5	

There are 8 discrepancies between the modelled and reference sequences:

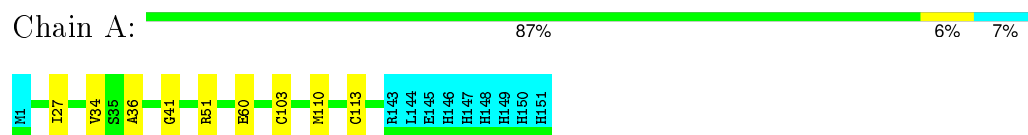
Chain	Residue	Modelled	Actual	Comment	Reference
A	144	LEU	-	EXPRESSION TAG	UNP Q47KK8
A	145	GLU	-	EXPRESSION TAG	UNP Q47KK8
A	146	HIS	-	EXPRESSION TAG	UNP Q47KK8
A	147	HIS	-	EXPRESSION TAG	UNP Q47KK8
A	148	HIS	-	EXPRESSION TAG	UNP Q47KK8
A	149	HIS	-	EXPRESSION TAG	UNP Q47KK8
A	150	HIS	-	EXPRESSION TAG	UNP Q47KK8
A	151	HIS	-	EXPRESSION TAG	UNP Q47KK8

4 Residue-property plots [i](#)

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA and DNA chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-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. Stretches of 2 or more consecutive residues without any outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

- Molecule 1: Uncharacterized protein

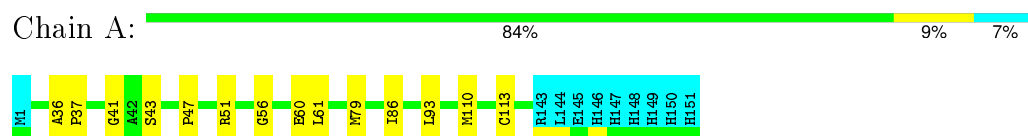


4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

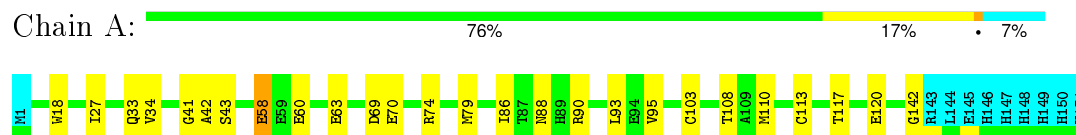
4.2.1 Score per residue for model 1

- Molecule 1: Uncharacterized protein



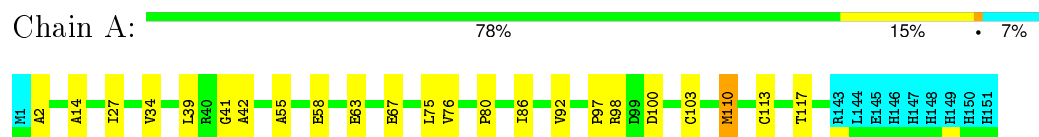
4.2.2 Score per residue for model 2

- Molecule 1: Uncharacterized protein



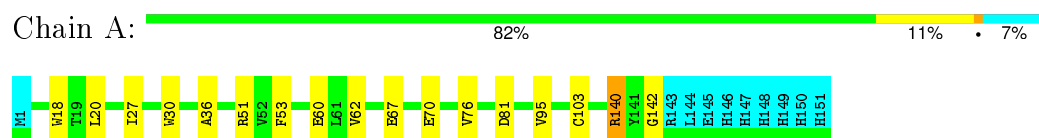
4.2.3 Score per residue for model 3

- Molecule 1: Uncharacterized protein



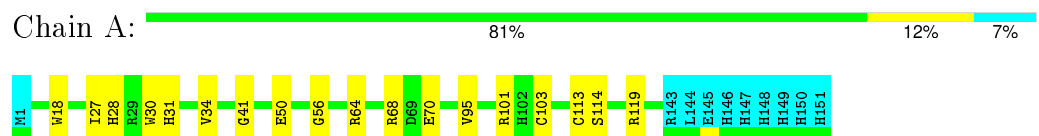
4.2.4 Score per residue for model 4

- Molecule 1: Uncharacterized protein



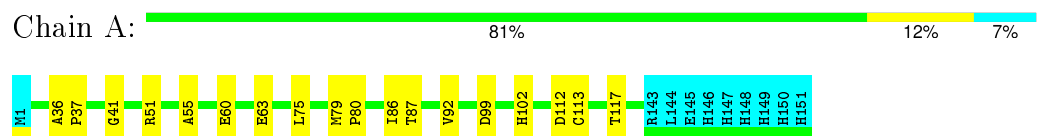
4.2.5 Score per residue for model 5

- Molecule 1: Uncharacterized protein



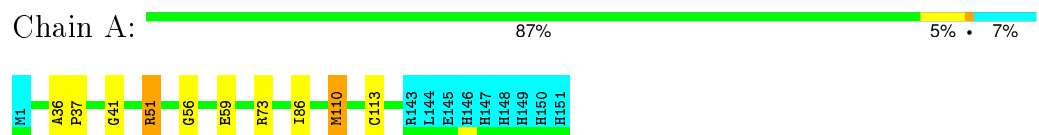
4.2.6 Score per residue for model 6

- Molecule 1: Uncharacterized protein



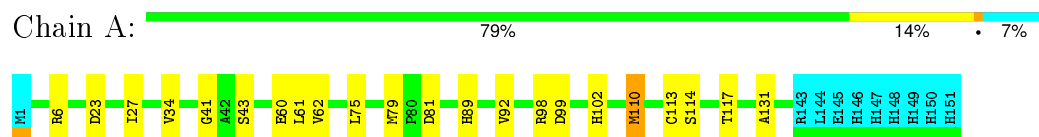
4.2.7 Score per residue for model 7 (medoid)

- Molecule 1: Uncharacterized protein



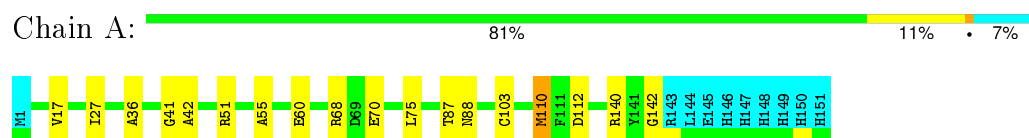
4.2.8 Score per residue for model 8

- Molecule 1: Uncharacterized protein



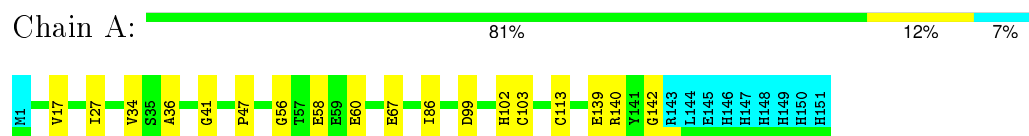
4.2.9 Score per residue for model 9

- Molecule 1: Uncharacterized protein



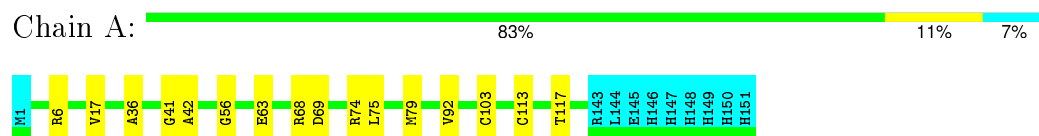
4.2.10 Score per residue for model 10

- Molecule 1: Uncharacterized protein



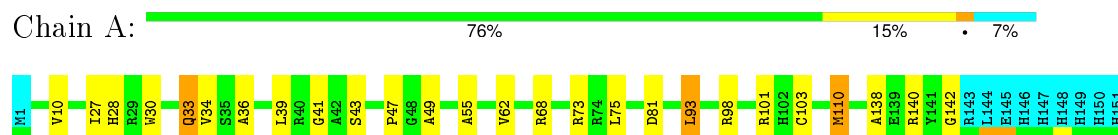
4.2.11 Score per residue for model 11

- Molecule 1: Uncharacterized protein



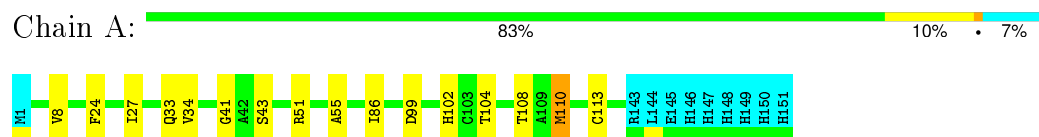
4.2.12 Score per residue for model 12

- Molecule 1: Uncharacterized protein



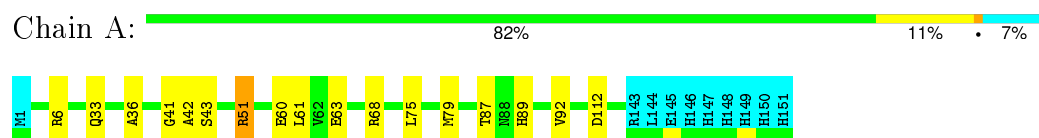
4.2.13 Score per residue for model 13

- Molecule 1: Uncharacterized protein



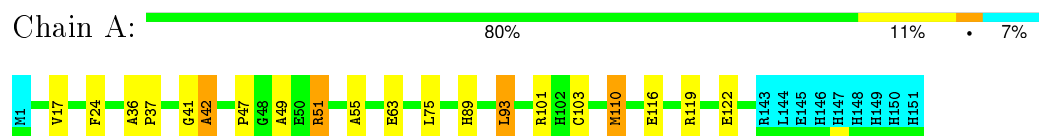
4.2.14 Score per residue for model 14

- Molecule 1: Uncharacterized protein



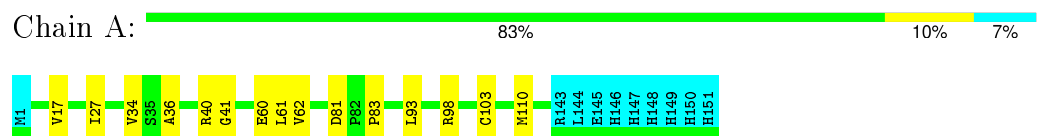
4.2.15 Score per residue for model 15

- Molecule 1: Uncharacterized protein



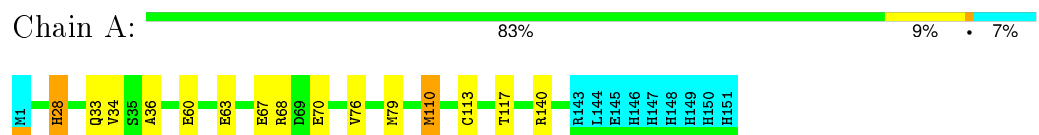
4.2.16 Score per residue for model 16

- Molecule 1: Uncharacterized protein



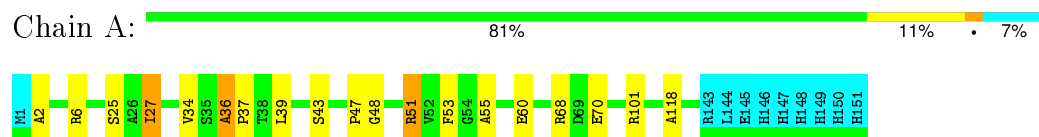
4.2.17 Score per residue for model 17

- Molecule 1: Uncharacterized protein



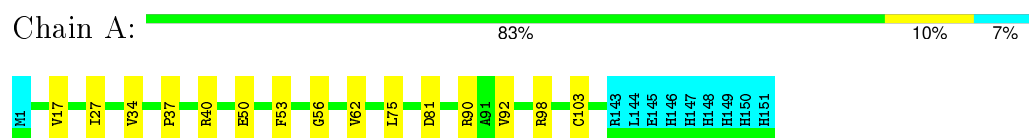
4.2.18 Score per residue for model 18

- Molecule 1: Uncharacterized protein



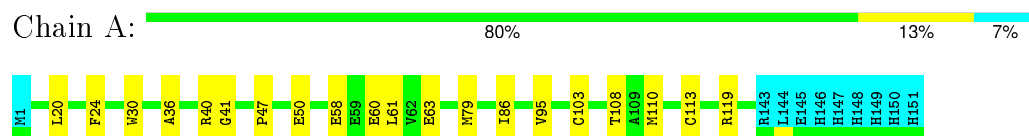
4.2.19 Score per residue for model 19

- Molecule 1: Uncharacterized protein



4.2.20 Score per residue for model 20

- Molecule 1: Uncharacterized protein



5 Refinement protocol and experimental data overview

The models were refined using the following method: *simulated annealing*.

Of the 100 calculated structures, 20 were deposited, based on the following criterion: *target function*.

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
TALOS+	geometry optimization	
PALES	geometry optimization	
CNS	refinement	

The following table shows chemical shift validation statistics as aggregates over all chemical shift files. Detailed validation can be found in section 7 of this report.

Chemical shift file(s)	2le1_cs.str
Number of chemical shift lists	1
Total number of shifts	1770
Number of shifts mapped to atoms	1770
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	89%

No validations of the models with respect to experimental NMR restraints is performed at this time.

6 Model quality ⓘ

6.1 Standard geometry ⓘ

There are no covalent bond-length or bond-angle outliers.

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	Planarity
1	A	0.0±0.0	0.1±0.3
All	All	0	2

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

All unique planar outliers are listed below.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	51	ARG	Sidechain	2

6.2 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 each 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 averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	1092	1061	1058	6±2
All	All	21840	21220	21160	124

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 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:28:HIS:HA	1:A:34:VAL:HG11	0.61	1.71	17	3
1:A:61:LEU:HD11	1:A:79:MET:SD	0.57	2.40	14	4

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:27:ILE:HG21	1:A:51:ARG:NH2	0.57	2.14	9	1
1:A:37:PRO:HB2	1:A:51:ARG:HB2	0.54	1.78	7	5
1:A:86:ILE:HG22	1:A:113:CYS:HB2	0.53	1.80	3	8
1:A:62:VAL:HB	1:A:81:ASP:HB3	0.53	1.81	8	5
1:A:6:ARG:HH11	1:A:131:ALA:HB2	0.53	1.64	8	1
1:A:37:PRO:HB3	1:A:53:PHE:HA	0.52	1.79	19	1
1:A:95:VAL:HB	1:A:103:CYS:SG	0.52	2.45	20	3
1:A:47:PRO:HG3	1:A:67:GLU:HA	0.52	1.81	10	1
1:A:27:ILE:HG23	1:A:34:VAL:HG11	0.51	1.82	19	8
1:A:68:ARG:HE	1:A:75:LEU:HD13	0.51	1.65	14	1
1:A:27:ILE:HG21	1:A:51:ARG:NH1	0.51	2.20	4	1
1:A:33:GLN:N	1:A:33:GLN:HE21	0.51	2.03	12	1
1:A:87:THR:HB	1:A:112:ASP:HB3	0.51	1.82	9	3
1:A:99:ASP:HB3	1:A:102:HIS:HB2	0.51	1.81	10	4
1:A:75:LEU:HB3	1:A:93:LEU:HB3	0.50	1.82	15	2
1:A:113:CYS:SG	1:A:117:THR:HB	0.50	2.47	17	6
1:A:31:HIS:O	1:A:34:VAL:HG12	0.50	2.07	5	1
1:A:110:MET:N	1:A:110:MET:SD	0.50	2.85	8	4
1:A:69:ASP:HB2	1:A:74:ARG:HB3	0.49	1.84	11	2
1:A:110:MET:SD	1:A:110:MET:N	0.49	2.86	15	4
1:A:17:VAL:HG21	1:A:103:CYS:SG	0.48	2.47	11	6
1:A:40:ARG:HB2	1:A:50:GLU:HB2	0.48	1.86	19	2
1:A:2:ALA:HB2	1:A:118:ALA:HB1	0.47	1.87	18	1
1:A:108:THR:HG22	1:A:110:MET:SD	0.47	2.49	2	3
1:A:67:GLU:HG2	1:A:76:VAL:HB	0.47	1.87	4	2
1:A:75:LEU:O	1:A:92:VAL:HA	0.47	2.10	6	6
1:A:18:TRP:HE1	1:A:70:GLU:HG3	0.47	1.69	2	2
1:A:68:ARG:NH1	1:A:70:GLU:HB2	0.47	2.25	18	1
1:A:25:SER:HA	1:A:39:LEU:HD21	0.46	1.87	18	1
1:A:68:ARG:HD3	1:A:75:LEU:HD13	0.46	1.87	9	1
1:A:63:GLU:HG2	1:A:79:MET:HG2	0.46	1.88	14	4
1:A:68:ARG:HH12	1:A:70:GLU:HB3	0.46	1.71	9	1
1:A:50:GLU:HG2	1:A:64:ARG:HG2	0.46	1.87	5	1
1:A:18:TRP:HE1	1:A:70:GLU:HA	0.46	1.70	4	1
1:A:61:LEU:HD13	1:A:83:PRO:HD3	0.46	1.86	16	1
1:A:61:LEU:HD21	1:A:79:MET:SD	0.44	2.53	8	1
1:A:42:ALA:HB3	1:A:49:ALA:HB2	0.44	1.89	15	1
1:A:14:ALA:N	1:A:103:CYS:SG	0.43	2.91	3	1
1:A:8:VAL:O	1:A:104:THR:HA	0.43	2.13	13	1
1:A:20:LEU:HD21	1:A:30:TRP:HB3	0.43	1.91	20	1
1:A:27:ILE:HA	1:A:30:TRP:NE1	0.43	2.29	4	3

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:67:GLU:HB3	1:A:76:VAL:HB	0.43	1.89	17	1
1:A:97:PRO:HA	1:A:103:CYS:SG	0.43	2.53	3	1
1:A:39:LEU:HD12	1:A:49:ALA:HB1	0.42	1.90	12	1
1:A:10:VAL:HB	1:A:103:CYS:SG	0.42	2.55	12	1
1:A:95:VAL:HG12	1:A:103:CYS:SG	0.41	2.55	4	1
1:A:53:PHE:O	1:A:60:GLU:HA	0.41	2.15	4	1
1:A:63:GLU:HG2	1:A:79:MET:HB3	0.41	1.91	2	1
1:A:63:GLU:HA	1:A:79:MET:HA	0.41	1.93	20	1
1:A:113:CYS:SG	1:A:114:SER:N	0.41	2.94	8	2
1:A:63:GLU:HA	1:A:80:PRO:HD2	0.41	1.92	6	2
1:A:20:LEU:HD22	1:A:140:ARG:HH11	0.41	1.76	4	1
1:A:34:VAL:HG12	1:A:36:ALA:H	0.40	1.75	18	1

6.3 Torsion angles

6.3.1 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 PDB entries followed by that with respect to all NMR entries. 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	141/151 (93%)	126±3 (89±2%)	11±2 (8±2%)	4±2 (3±1%)	10	44
All	All	2820/3020 (93%)	2522 (89%)	218 (8%)	80 (3%)	10	44

All 17 unique Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	41	GLY	16
1	A	36	ALA	14
1	A	55	ALA	7
1	A	43	SER	7
1	A	56	GLY	6
1	A	42	ALA	6
1	A	47	PRO	5
1	A	142	GLY	5
1	A	58	GLU	4
1	A	89	HIS	3

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Models (Total)
1	A	100	ASP	1
1	A	53	PHE	1
1	A	2	ALA	1
1	A	88	ASN	1
1	A	59	GLU	1
1	A	27	ILE	1
1	A	48	GLY	1

6.3.2 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 PDB entries followed by that with respect to all NMR entries. 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	115/125 (92%)	111±2 (97±2%)	4±2 (3±2%)	49	89
All	All	2300/2500 (92%)	2223 (97%)	77 (3%)	49	89

All 25 unique residues with a non-rotameric sidechain are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	60	GLU	11
1	A	110	MET	10
1	A	98	ARG	5
1	A	33	GLN	5
1	A	93	LEU	5
1	A	140	ARG	5
1	A	68	ARG	4
1	A	51	ARG	4
1	A	101	ARG	4
1	A	24	PHE	3
1	A	119	ARG	3
1	A	6	ARG	3
1	A	90	ARG	2
1	A	73	ARG	2
1	A	58	GLU	1
1	A	39	LEU	1
1	A	120	GLU	1
1	A	40	ARG	1

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Models (Total)
1	A	70	GLU	1
1	A	116	GLU	1
1	A	122	GLU	1
1	A	63	GLU	1
1	A	88	ASN	1
1	A	23	ASP	1
1	A	28	HIS	1

6.3.3 RNA [i](#)

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains [i](#)

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

6.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

6.6 Ligand geometry [i](#)

There are no ligands in this entry.

6.7 Other polymers [i](#)

There are no such molecules in this entry.

6.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

7 Chemical shift validation

The completeness of assignment taking into account all chemical shift lists is 89% for the well-defined parts and 84% for the entire structure.

7.1 Chemical shift list 1

File name: 2le1_cs.str

Chemical shift list name: *assigned_chem_shift_list_1*

7.1.1 Bookkeeping

The following table shows the results of parsing the chemical shift list and reports the number of nuclei with statistically unusual chemical shifts.

Total number of shifts	1770
Number of shifts mapped to atoms	1770
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	4

7.1.2 Chemical shift referencing

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction \pm precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	144	0.25 ± 0.13	None needed (< 0.5 ppm)
$^{13}\text{C}_\beta$	135	-0.12 ± 0.08	None needed (< 0.5 ppm)
$^{13}\text{C}'$	143	0.44 ± 0.22	None needed (< 0.5 ppm)
^{15}N	132	0.47 ± 0.34	None needed (< 0.5 ppm)

7.1.3 Completeness of resonance assignments

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 89%, i.e. 1513 atoms were assigned a chemical shift out of a possible 1699. 27 out of 27 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^1H	^{13}C	^{15}N
Backbone	680/683 (100%)	270/271 (100%)	281/282 (100%)	129/130 (99%)
Sidechain	711/879 (81%)	435/513 (85%)	271/321 (84%)	5/45 (11%)

Continued on next page...

Continued from previous page...

	Total	¹H	¹³C	¹⁵N
Aromatic	122/137 (89%)	59/71 (83%)	51/53 (96%)	12/13 (92%)
Overall	1513/1699 (89%)	764/855 (89%)	603/656 (92%)	146/188 (78%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 84%, i.e. 1552 atoms were assigned a chemical shift out of a possible 1857. 28 out of 28 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	¹H	¹³C	¹⁵N
Backbone	695/733 (95%)	276/291 (95%)	287/302 (95%)	132/140 (94%)
Sidechain	735/939 (78%)	450/550 (82%)	280/341 (82%)	5/48 (10%)
Aromatic	122/185 (66%)	59/95 (62%)	51/65 (78%)	12/25 (48%)
Overall	1552/1857 (84%)	785/936 (84%)	618/708 (87%)	149/213 (70%)

7.1.4 Statistically unusual chemical shifts ⓘ

The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, ppm	Expected range, ppm	Z-score
1	A	51	ARG	HD3	0.95	4.36 – 1.86	-8.6
1	A	22	GLY	HA3	1.01	5.80 – 2.00	-7.6
1	A	73	ARG	HA	1.21	6.59 – 1.99	-6.7
1	A	73	ARG	HG2	0.13	2.92 – 0.22	-5.3

7.1.5 Random Coil Index (RCI) plots ⓘ

The image below reports *random coil index* values for the protein chains in the structure. The height of each bar gives a probability of a given residue to be disordered, as predicted from the available chemical shifts and the amino acid sequence. A value above 0.2 is an indication of significant predicted disorder. The colour of the bar shows whether the residue is in the well-defined core (black) or in the ill-defined residue ranges (cyan), as described in section 2 on ensemble composition.

Random coil index (RCI) for chain A:

