



Full wwPDB NMR Structure Validation Report ⓘ

Mar 5, 2026 – 01:44 AM UTC

PDB ID : 2POA / pdb_00002poa
BMRB ID : 6150
Title : Schistosoma mansoni Sm14 Fatty Acid-Binding Protein: improvement of protein stability by substitution of the single Cys62 residue
Authors : Ramos, C.R.R.; Oyama Jr., S.; Sforca, M.L.; Pertinhez, T.A.; Ho, P.L.; Spisni, A.
Deposited on : 2007-04-26

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

<https://www.wwpdb.org/validation/2017/NMRValidationReportHelp>

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
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
wwPDB-RCI : v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV : Wang et al. (2010)
wwPDB-ShiftChecker : v1.2
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

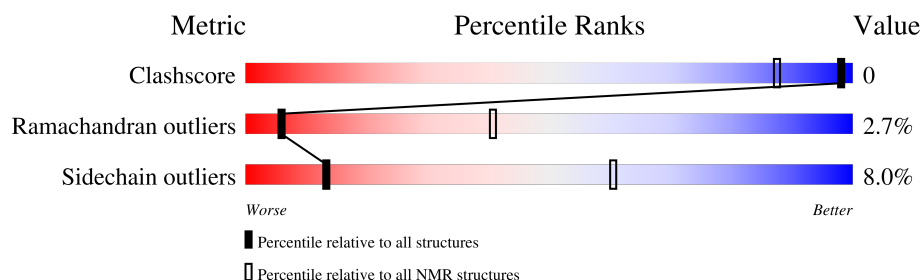
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment is 81%.

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	229148	14424
Ramachandran outliers	224038	12848
Sidechain outliers	223484	12823

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	133	

2 Ensemble composition and analysis

This entry contains 17 models. Model 13 is the overall representative, medoid model (most similar to other models). The authors have identified model 17 as representative, based on the following criterion: *fewest violations*.

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:4-A:132 (129)	0.76	13

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 3 clusters and 6 single-model clusters were found.

Cluster number	Models
1	1, 4, 5, 7, 13, 16
2	8, 12, 17
3	9, 10
Single-model clusters	2; 3; 6; 11; 14; 15

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 2080 atoms, of which 1042 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called 14 kDa fatty acid-binding protein.

Mol	Chain	Residues	Atoms						Trace
1	A	133	Total	C	H	N	O	S	0
			2080	646	1042	175	211	6	

There is a discrepancy between the modelled and reference sequences:

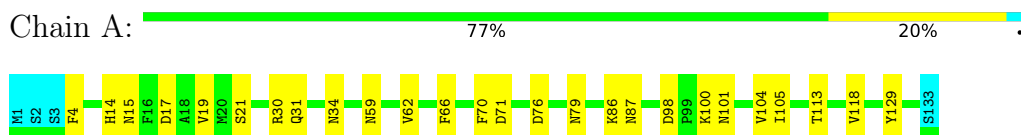
Chain	Residue	Modelled	Actual	Comment	Reference
A	62	VAL	CYS	engineered mutation	UNP P29498

4 Residue-property plots

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA, DNA and oligosaccharide 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: 14 kDa fatty acid-binding protein

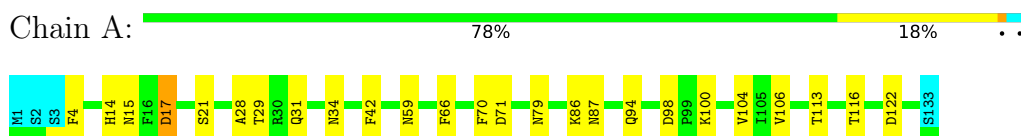


4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

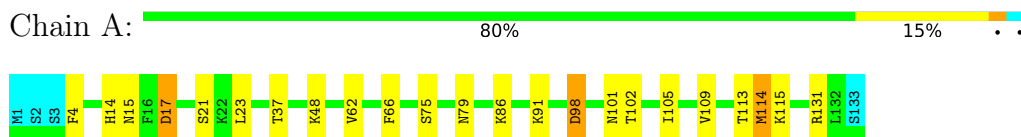
4.2.1 Score per residue for model 1

- Molecule 1: 14 kDa fatty acid-binding protein



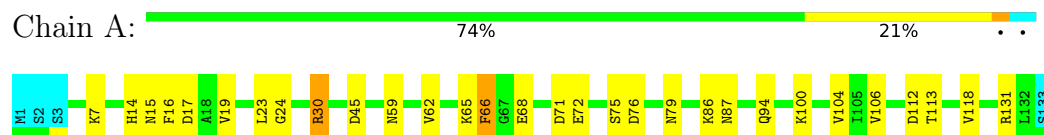
4.2.2 Score per residue for model 2

- Molecule 1: 14 kDa fatty acid-binding protein



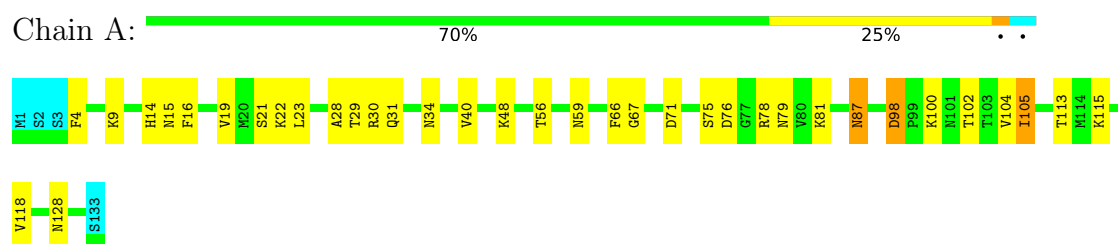
4.2.3 Score per residue for model 3

- Molecule 1: 14 kDa fatty acid-binding protein



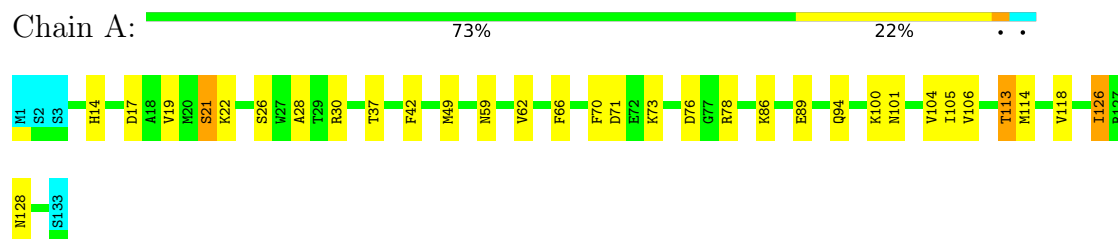
4.2.4 Score per residue for model 4

- Molecule 1: 14 kDa fatty acid-binding protein



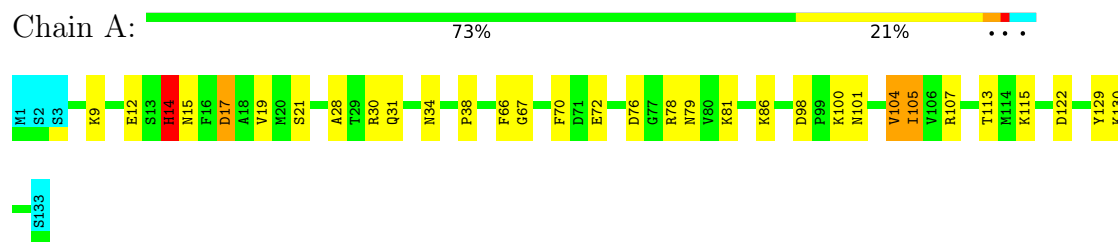
4.2.5 Score per residue for model 5

- Molecule 1: 14 kDa fatty acid-binding protein



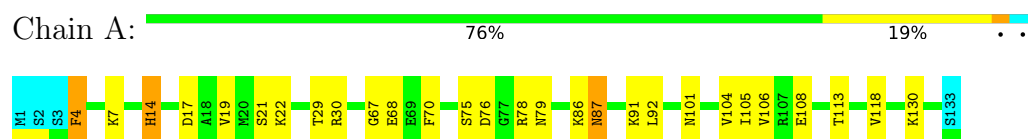
4.2.6 Score per residue for model 6

- Molecule 1: 14 kDa fatty acid-binding protein



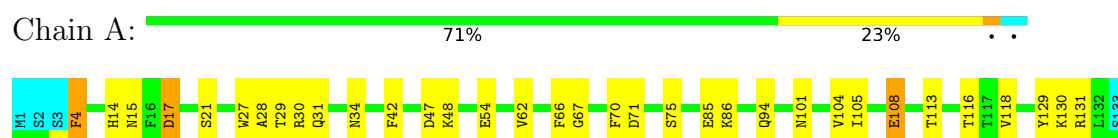
4.2.7 Score per residue for model 7

- Molecule 1: 14 kDa fatty acid-binding protein



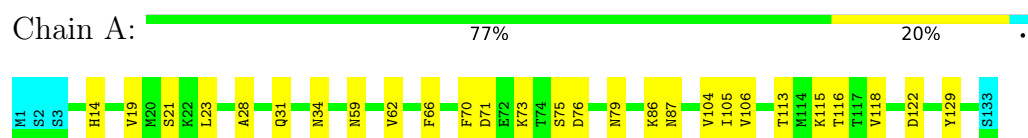
4.2.8 Score per residue for model 8

- Molecule 1: 14 kDa fatty acid-binding protein



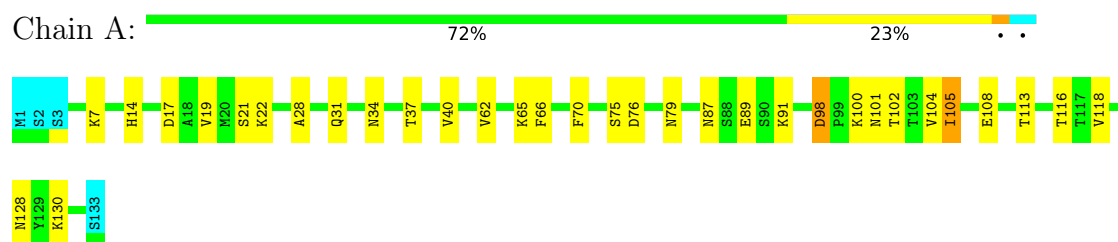
4.2.9 Score per residue for model 9

- Molecule 1: 14 kDa fatty acid-binding protein



4.2.10 Score per residue for model 10

- Molecule 1: 14 kDa fatty acid-binding protein



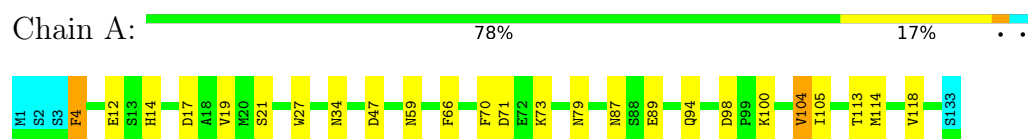
4.2.11 Score per residue for model 11

- Molecule 1: 14 kDa fatty acid-binding protein



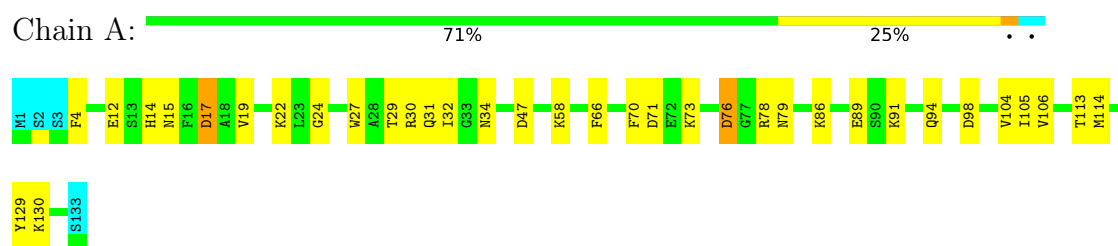
4.2.16 Score per residue for model 16

- Molecule 1: 14 kDa fatty acid-binding protein



4.2.17 Score per residue for model 17

- Molecule 1: 14 kDa fatty acid-binding protein



5 Refinement protocol and experimental data overview

The models were refined using the following method: *torsion angle dynamics using dyana software and further minimization with discover module of the insight package.*

Of the 40 calculated structures, 17 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
DYANA	structure solution	1.5
Discover	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)	working_cs.cif
Number of chemical shift lists	1
Total number of shifts	1439
Number of shifts mapped to atoms	1439
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	81%

6 Model quality

6.1 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 (average) 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	1.54±0.01	3±1/1027 (0.2± 0.1%)	1.65±0.03	18±3/1387 (1.3± 0.2%)
All	All	1.54	43/17459 (0.2%)	1.65	304/23579 (1.3%)

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	2.3±1.1
All	All	0	39

All unique bond outliers are listed below. They are sorted according to the Z-score of the worst occurrence in the ensemble.

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)	Models	
								Worst	Total
1	A	14	HIS	CG-CD2	6.41	1.43	1.35	4	17
1	A	76	ASP	CA-C	5.96	1.60	1.52	14	2
1	A	89	GLU	CA-C	5.43	1.60	1.52	17	1
1	A	15	ASN	CA-C	5.39	1.59	1.53	3	4
1	A	100	LYS	CA-C	5.33	1.59	1.52	5	5
1	A	14	HIS	CE1-NE2	5.30	1.37	1.32	14	9
1	A	28	ALA	CA-C	5.26	1.57	1.52	8	2
1	A	106	VAL	CA-C	5.23	1.58	1.52	9	1
1	A	47	ASP	CA-C	5.08	1.57	1.52	16	2

All unique angle outliers are listed below. They are sorted according to the Z-score of the worst occurrence in the ensemble.

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
1	A	71	ASP	CA-CB-CG	11.39	123.99	112.60	17	12

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
1	A	4	PHE	CA-CB-CG	11.26	125.06	113.80	8	10
1	A	14	HIS	ND1-CE1-NE2	10.41	118.81	108.40	12	17
1	A	76	ASP	CA-CB-CG	8.51	121.11	112.60	13	9
1	A	14	HIS	CE1-NE2-CD2	-8.36	100.64	109.00	9	17
1	A	45	ASP	CA-CB-CG	8.29	120.89	112.60	3	1
1	A	15	ASN	CA-CB-CG	8.19	120.79	112.60	8	9
1	A	79	ASN	CA-CB-CG	7.79	120.39	112.60	1	12
1	A	37	THR	N-CA-C	7.68	118.43	109.60	10	4
1	A	87	ASN	CA-CB-CG	7.67	120.27	112.60	3	4
1	A	66	PHE	CA-CB-CG	7.61	121.41	113.80	8	16
1	A	17	ASP	CA-CB-CG	7.21	119.81	112.60	10	14
1	A	34	ASN	CA-CB-CG	7.15	119.75	112.60	4	13
1	A	70	PHE	CA-CB-CG	6.71	120.51	113.80	6	10
1	A	19	VAL	N-CA-C	6.50	117.19	110.36	13	11
1	A	47	ASP	CA-CB-CG	6.49	119.09	112.60	12	4
1	A	116	THR	CA-CB-CG2	6.44	121.45	110.50	10	7
1	A	76	ASP	N-CA-CB	-6.25	100.95	110.01	11	7
1	A	59	ASN	CA-CB-CG	6.22	118.82	112.60	13	10
1	A	16	PHE	N-CA-CB	-6.20	102.96	110.53	4	2
1	A	21	SER	N-CA-C	6.16	118.00	111.28	10	13
1	A	126	ILE	CB-CA-C	6.12	118.29	111.80	5	1
1	A	113	THR	CA-CB-CG2	6.11	120.88	110.50	10	17
1	A	118	VAL	CB-CA-C	6.09	119.74	111.88	9	11
1	A	94	GLN	N-CA-CB	-5.99	102.90	110.45	14	4
1	A	75	SER	N-CA-C	5.91	118.51	111.71	7	8
1	A	122	ASP	CA-CB-CG	5.87	118.47	112.60	1	4
1	A	54	GLU	N-CA-CB	-5.81	102.34	111.23	15	1
1	A	86	LYS	N-CA-CB	-5.78	101.23	109.85	6	1
1	A	27	TRP	N-CA-C	5.76	119.50	111.90	16	1
1	A	98	ASP	N-CA-CB	-5.74	103.17	109.72	6	2
1	A	98	ASP	CA-CB-CG	5.72	118.32	112.60	13	8
1	A	81	LYS	CB-CA-C	5.61	120.16	110.45	4	2
1	A	45	ASP	N-CA-CB	-5.61	103.00	110.57	3	1
1	A	113	THR	CB-CA-C	5.60	119.55	111.82	5	2
1	A	118	VAL	CA-CB-CG1	5.59	119.90	110.40	3	6
1	A	115	LYS	N-CA-CB	-5.56	102.25	110.49	6	1
1	A	29	THR	N-CA-C	5.56	118.27	111.82	8	5
1	A	76	ASP	N-CA-C	5.55	118.09	111.71	15	4
1	A	128	ASN	CA-CB-CG	5.44	118.04	112.60	4	3
1	A	72	GLU	CB-CA-C	5.42	118.80	110.62	12	1
1	A	83	VAL	CB-CA-C	5.31	117.43	111.80	15	1

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
1	A	68	GLU	CB-CG-CD	5.28	121.58	112.60	3	1
1	A	105	ILE	CA-CB-CG1	5.27	119.36	110.40	10	3
1	A	56	THR	N-CA-C	5.24	116.99	111.28	4	1
1	A	34	ASN	N-CA-C	5.23	119.22	113.21	9	1
1	A	104	VAL	N-CA-C	5.20	120.16	109.34	6	3
1	A	108	GLU	N-CA-CB	-5.18	102.72	110.60	8	1
1	A	107	ARG	CA-CB-CG	5.17	124.43	114.10	15	1
1	A	92	LEU	N-CA-CB	-5.15	102.77	110.60	7	1
1	A	14	HIS	CG-ND1-CE1	-5.10	100.63	109.30	13	1
1	A	26	SER	N-CA-C	5.04	117.03	110.43	5	1
1	A	112	ASP	N-CA-C	5.04	118.39	111.54	3	1
1	A	34	ASN	OD1-CG-ND2	-5.04	117.56	122.60	9	1
1	A	42	PHE	CA-CB-CG	5.03	118.83	113.80	1	1
1	A	129	TYR	CA-CB-CG	5.00	122.91	113.90	15	1

There are no chirality outliers.

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

Mol	Chain	Res	Type	Group	Models (Total)
1	A	129	TYR	Sidechain	7
1	A	78	ARG	Sidechain	6
1	A	87	ASN	Peptide	5
1	A	131	ARG	Sidechain	3
1	A	30	ARG	Sidechain	3
1	A	40	VAL	Peptide	3
1	A	89	GLU	Peptide	2
1	A	14	HIS	Peptide	2
1	A	27	TRP	Peptide	2
1	A	68	GLU	Peptide	1
1	A	47	ASP	Peptide	1
1	A	127	ARG	Sidechain	1
1	A	84	VAL	Peptide	1
1	A	100	LYS	Peptide	1
1	A	114	MET	Peptide	1

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	1012	1016	1016	1±1
All	All	17204	17272	17272	14

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 0.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:105:ILE:HD12	1:A:105:ILE:O	0.53	2.03	4	5
1:A:4:PHE:CD2	1:A:114:MET:SD	0.48	3.06	16	1
1:A:105:ILE:H	1:A:105:ILE:HD13	0.46	1.69	14	2
1:A:98:ASP:OD2	1:A:102:THR:OG1	0.44	2.30	2	1
1:A:29:THR:OG1	1:A:76:ASP:OD1	0.44	2.35	17	2
1:A:98:ASP:OD1	1:A:102:THR:OG1	0.44	2.35	10	2
1:A:109:VAL:HB	1:A:114:MET:SD	0.42	2.54	2	1

6.3 Torsion angles [i](#)

6.3.1 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 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	129/133 (97%)	98±4 (76±3%)	27±4 (21±3%)	3±1 (3±1%)	6	41
All	All	2193/2261 (97%)	1667 (76%)	467 (21%)	59 (3%)	6	41

All 13 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	104	VAL	15
1	A	101	ASN	10
1	A	106	VAL	7
1	A	28	ALA	6
1	A	24	GLY	6
1	A	67	GLY	6

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Mol	Chain	Res	Type	Models (Total)
1	A	17	ASP	2
1	A	105	ILE	2
1	A	114	MET	1
1	A	66	PHE	1
1	A	38	PRO	1
1	A	35	THR	1
1	A	27	TRP	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	118/122 (97%)	109±3 (92±3%)	9±3 (8±3%)	13	60
All	All	2006/2074 (97%)	1846 (92%)	160 (8%)	13	60

All 44 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	86	LYS	13
1	A	31	GLN	12
1	A	62	VAL	9
1	A	30	ARG	8
1	A	22	LYS	8
1	A	105	ILE	8
1	A	17	ASP	7
1	A	12	GLU	7
1	A	91	LYS	6
1	A	130	LYS	6
1	A	23	LEU	5
1	A	100	LYS	5
1	A	73	LYS	5
1	A	94	GLN	4
1	A	115	LYS	4
1	A	7	LYS	4
1	A	9	LYS	4
1	A	108	GLU	4

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Mol	Chain	Res	Type	Models (Total)
1	A	48	LYS	3
1	A	72	GLU	3
1	A	42	PHE	3
1	A	4	PHE	3
1	A	65	LYS	2
1	A	21	SER	2
1	A	126	ILE	2
1	A	81	LYS	2
1	A	85	GLU	2
1	A	32	ILE	2
1	A	76	ASP	2
1	A	131	ARG	1
1	A	87	ASN	1
1	A	113	THR	1
1	A	114	MET	1
1	A	14	HIS	1
1	A	107	ARG	1
1	A	54	GLU	1
1	A	116	THR	1
1	A	10	LEU	1
1	A	127	ARG	1
1	A	8	TRP	1
1	A	112	ASP	1
1	A	129	TYR	1
1	A	89	GLU	1
1	A	58	LYS	1

6.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

6.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.6 Ligand geometry

There are no ligands in this entry.

6.7 Other polymers

There are no such molecules in this entry.

6.8 Polymer linkage issues

There are no chain breaks in this entry.

7 Chemical shift validation

The completeness of assignment taking into account all chemical shift lists is 81% for the well-defined parts and 81% for the entire structure.

7.1 Chemical shift list 1

File name: working_cs.cif

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	1439
Number of shifts mapped to atoms	1439
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	1

7.1.2 Chemical shift referencing

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction $\pm$ precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	133	1.84 ± 0.13	Should be applied
$^{13}\text{C}_\beta$	123	1.54 ± 0.09	Should be applied
$^{13}\text{C}'$	130	0.59 ± 0.14	Should be applied
^{15}N	130	-0.27 ± 0.24	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 81%, i.e. 1402 atoms were assigned a chemical shift out of a possible 1733. 0 out of 22 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^1H	^{13}C	^{15}N
Backbone	647/649 (100%)	264/264 (100%)	256/258 (99%)	127/127 (100%)
Sidechain	698/973 (72%)	462/628 (74%)	233/307 (76%)	3/38 (8%)

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	Total	¹H	¹³C	¹⁵N
Aromatic	57/111 (51%)	30/55 (55%)	25/52 (48%)	2/4 (50%)
Overall	1402/1733 (81%)	756/947 (80%)	514/617 (83%)	132/169 (78%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 81%, i.e. 1427 atoms were assigned a chemical shift out of a possible 1772. 0 out of 22 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	¹H	¹³C	¹⁵N
Backbone	664/669 (99%)	271/272 (100%)	263/266 (99%)	130/131 (99%)
Sidechain	706/992 (71%)	466/641 (73%)	237/313 (76%)	3/38 (8%)
Aromatic	57/111 (51%)	30/55 (55%)	25/52 (48%)	2/4 (50%)
Overall	1427/1772 (81%)	767/968 (79%)	525/631 (83%)	135/173 (78%)

7.1.4 Statistically unusual chemical shifts [i](#)

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.

List Id	Chain	Res	Type	Atom	Shift, ppm	Expected range, ppm	Z-score
1	A	78	ARG	CD	38.31	38.57 – 47.75	-5.3

7.1.5 Random Coil Index (RCI) plots [i](#)

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. If well-defined core and ill-defined regions are not identified then it is shown as gray bars.

Random coil index (RCI) for chain A:

