Full wwPDB NMR Structure Validation Report (i)

Jun 4, 2023 – 01:57 PM EDT

PDB ID	:	2KXX
BMRB ID	:	16926
Title	:	NMR Structure of Escherichia coli BamE, a Lipoprotein Component of the beta-Barrel Assembly Machinery Complex
Authors	:	Kim, K.; Okon, M.; Escobar, E.; Kang, H.; McIntosh, L.; Paetzel, M.
Deposited on	:	2010-05-13

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 (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:

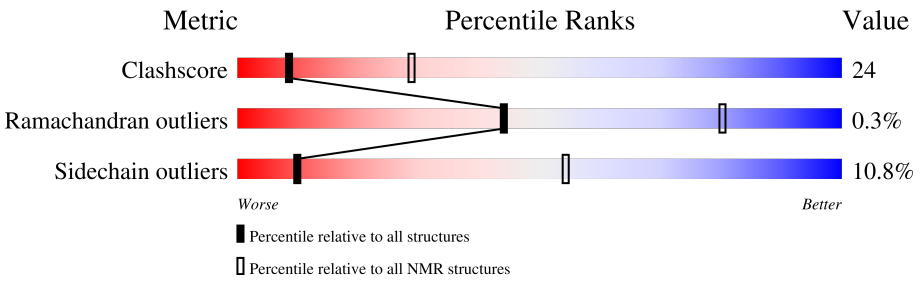
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
wwPDB-RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
wwPDB-ShiftChecker	:	v1.2
BMRB Restraints Analysis	:	v1.2
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.33

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
SOLUTION NMR

The overall completeness of chemical shifts assignment is 78%.

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	158937	12864
Ramachandran outliers	154571	11451
Sidechain outliers	154315	11428

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 <=5%

Mol	Chain	Length	Quality of chain
1	A	97	34% 25% • 40%

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 11 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 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:38-A:77, A:90-A:107 (58)	0.34	11

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 5 single-model clusters were found.

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

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 1485 atoms, of which 732 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Small protein A.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	97	1485	470	732	132	148	3	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	17	GLY	-	expression tag	UNP P0A937
A	18	SER	-	expression tag	UNP P0A937
A	19	HIS	-	expression tag	UNP P0A937
A	20	MET	-	expression tag	UNP P0A937

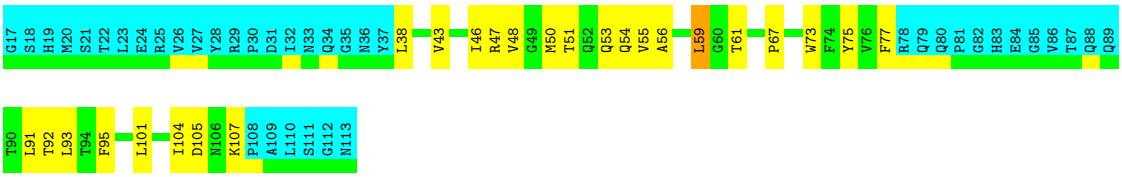
4 Residue-property plots (i)

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: Small protein A

Chain A: 34% 25% • 40%



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

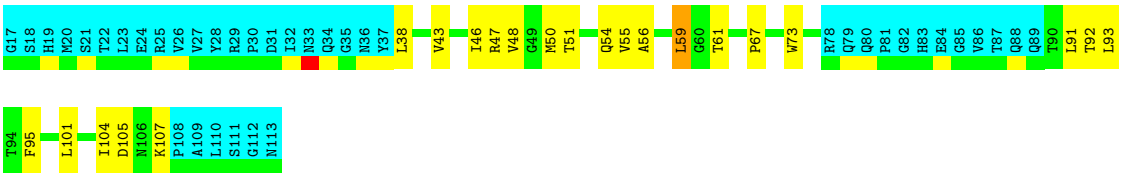
• Molecule 1: Small protein A

Chain A: 36% 22% • 40%

4.2.2 Score per residue for model 2

• Molecule 1: Small protein A

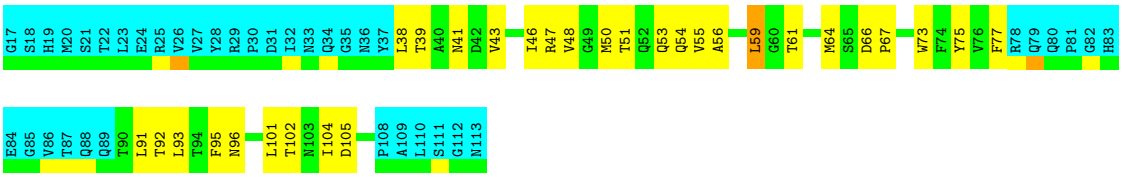
Chain A: 37% 22% • 40%



4.2.3 Score per residue for model 3

- Molecule 1: Small protein A

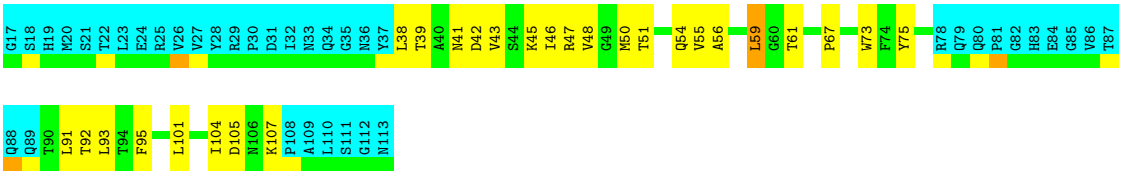
Chain A: 29% 30% • 40%



4.2.4 Score per residue for model 4

- Molecule 1: Small protein A

Chain A: 32% 27% • 40%



4.2.5 Score per residue for model 5

- Molecule 1: Small protein A

Chain A: 39% 19% • 40%

4.2.6 Score per residue for model 6

- Molecule 1: Small protein A

Chain A: 33% 24% • 40%

G17 S18 H19 M20 S21 T22 L23 E24 R25 V26 V27 Y28 R29 P30 D31 I32 N33 Q34 G35 N36 Y37 L38 T39 A40 N41 D42 V43 I46 R47 V48 G49 M50 T51 Q52 Q53 Q54 V55 A56 L59 G60 T61 M64 P67 W73 R78 Q79 Q80 P81 G82 H83 E84 G85 V86 T87

Q88 Q89 T90 L91 T92 L93 T94 F95 L101 I104 D105 N106 K107 P108 A109 L110 S111 G112 N113

4.2.7 Score per residue for model 7

- Molecule 1: Small protein A

Chain A: 31% 27% • 40%

G17 S18 H19 M20 S21 T22 L23 E24 R25 V26 V27 Y28 R29 P30 D31 I32 N33 Q34 G35 N36 Y37 L38 D42 V43 S44 K45 I46 R47 V48 G49 M50 T51 Q54 V55 A56 L59 G60 T61 P67 W73 F74 Y75 V76 F77 R78 Q79 Q80 P81 G82 H83 E84 G85 V86 T87 Q88

Q89 T90 L91 T92 L93 T94 F95 S98 G99 V100 L101 I104 D105 P108 A109 L110 S111 G112 N113

4.2.8 Score per residue for model 8

- Molecule 1: Small protein A

Chain A: 31% 27% • 40%

G17 S18 H19 M20 S21 T22 L23 E24 R25 V26 V27 Y28 R29 P30 D31 I32 N33 Q34 G35 N36 Y37 L38 T39 A40 N41 D42 V43 I46 R47 V48 G49 M50 T51 Q52 Q53 Q54 V55 A56 L59 G60 T61 P62 L63 P67 W73 F74 Y75 V76 F77 R78 Q79 Q80 P81 G82 H83 E84

G85 V86 T87 Q88 Q89 T90 L91 T92 L93 L101 I104 D105 N106 K107 P108 A109 L110 S111 G112 N113

4.2.9 Score per residue for model 9

- Molecule 1: Small protein A

Chain A: 38% 21% • 40%

G17 S18 H19 M20 S21 T22 L23 E24 R25 V26 V27 Y28 R29 P30 D31 I32 N33 Q34 G35 N36 Y37 L38 D42 V43 I46 R47 V48 T51 Q54 V55 L59 M64 P67 W73 V76 F77 R78 Q79 Q80 P81 G82 H83 E84 G85 V86 T87 Q88 Q89 T90 L91 T92

L93 T94 F95 L101 I104 K107 P108 A109 L110 S111 G112 N113

4.2.10 Score per residue for model 10

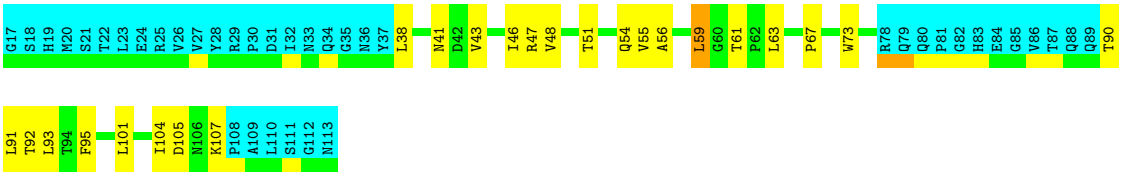
- Molecule 1: Small protein A

Chain A: 32% 24% • 40%

4.2.11 Score per residue for model 11 (medoid)

- Molecule 1: Small protein A

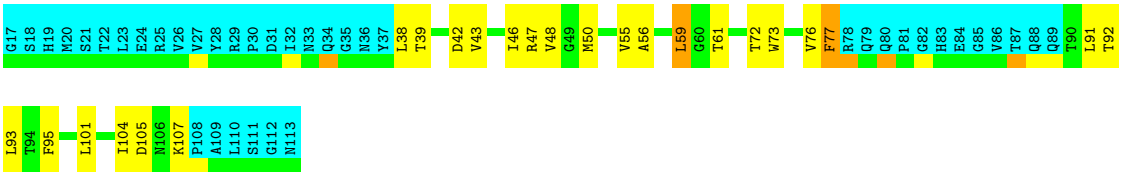
Chain A: 35% 24% • 40%



4.2.12 Score per residue for model 12

- Molecule 1: Small protein A

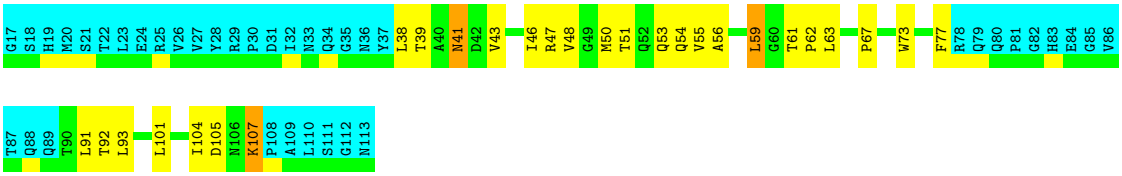
Chain A: 35% 23% • 40%



4.2.13 Score per residue for model 13

- Molecule 1: Small protein A

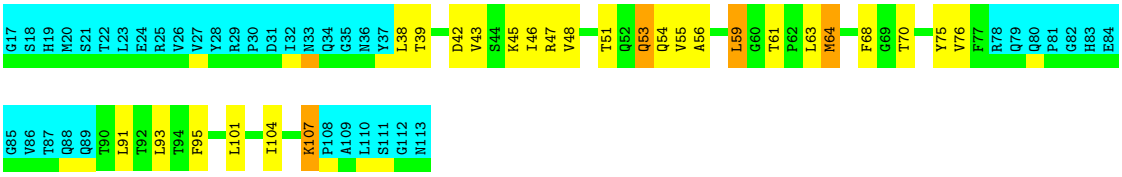
Chain A: 32% 25% • 40%



4.2.14 Score per residue for model 14

- Molecule 1: Small protein A

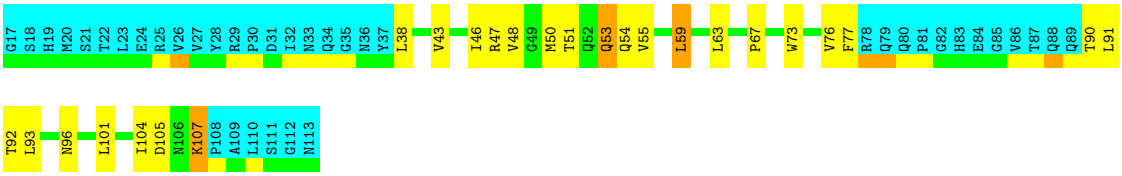
Chain A: 32% 24% • 40%



4.2.15 Score per residue for model 15

- Molecule 1: Small protein A

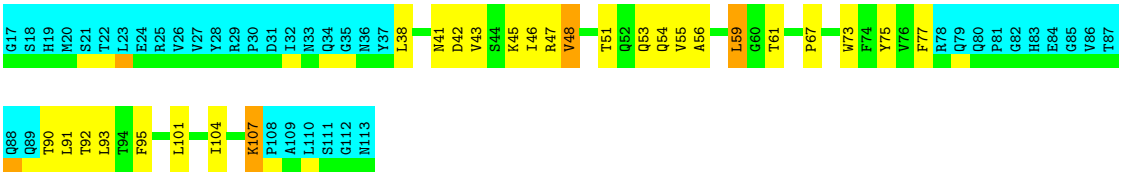
Chain A: 34% 23% • 40%



4.2.16 Score per residue for model 16

- Molecule 1: Small protein A

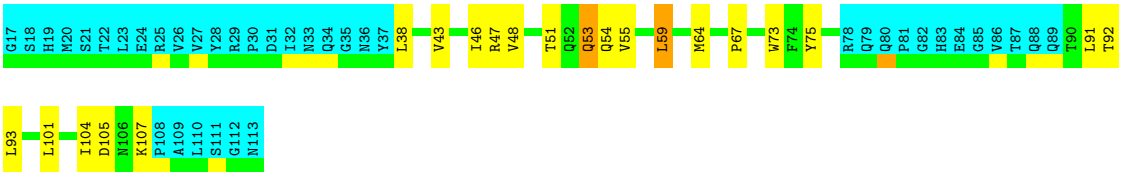
Chain A: 32% 25% • 40%



4.2.17 Score per residue for model 17

- Molecule 1: Small protein A

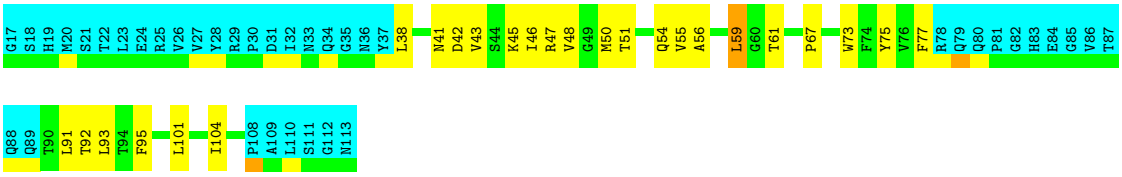
Chain A: 38% 20% • 40%



4.2.18 Score per residue for model 18

- Molecule 1: Small protein A

Chain A: 34% 25% • 40%



4.2.19 Score per residue for model 19

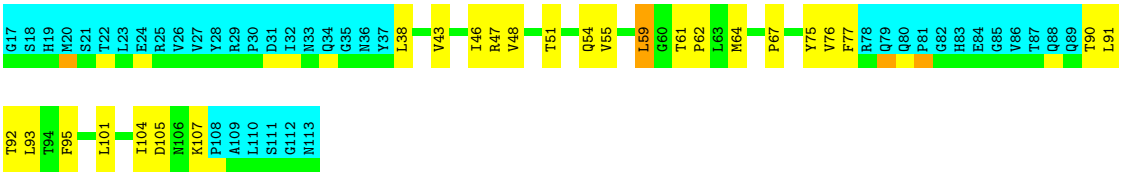
- Molecule 1: Small protein A

Chain A: 34% 25% • 40%

4.2.20 Score per residue for model 20

- Molecule 1: Small protein A

Chain A: 34% 25% • 40%



5 Refinement protocol and experimental data overview (i)

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

Of the 100 calculated structures, 20 were deposited, based on the following criterion: *structures with the least restraint violations*.

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

Software name	Classification	Version
CYANA	structure solution	2.1
CYANA	refinement	2.1
ARIA	refinement	2.0

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	872
Number of shifts mapped to atoms	872
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	78%

6 Model quality (i)

6.1 Standard geometry (i)

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

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

There are no planarity outliers.

6.2 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 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	449	444	444	21±3
All	All	8980	8880	8880	429

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 24.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:91:LEU:HD11	1:A:104:ILE:HG22	0.99	1.30	14	20
1:A:93:LEU:HG	1:A:101:LEU:HD21	0.80	1.52	7	20
1:A:43:VAL:HG22	1:A:91:LEU:HD22	0.78	1.52	9	19
1:A:91:LEU:HD11	1:A:104:ILE:CG2	0.70	2.15	10	20
1:A:46:ILE:HG23	1:A:59:LEU:HD13	0.69	1.65	6	19
1:A:38:LEU:HD11	1:A:59:LEU:HG	0.69	1.65	7	5
1:A:51:THR:H	1:A:54:GLN:HG3	0.68	1.46	3	19
1:A:93:LEU:CG	1:A:101:LEU:HD21	0.68	2.18	7	20
1:A:38:LEU:CD1	1:A:59:LEU:HG	0.65	2.20	12	19
1:A:38:LEU:HD13	1:A:59:LEU:HG	0.65	1.69	13	11
1:A:55:VAL:HG11	1:A:93:LEU:CD2	0.61	2.26	14	20
1:A:55:VAL:HG11	1:A:93:LEU:HD22	0.60	1.73	14	19
1:A:67:PRO:HB2	1:A:73:TRP:CZ2	0.60	2.31	13	15
1:A:56:ALA:HB1	1:A:61:THR:HG22	0.59	1.73	14	16

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:73:TRP:O	1:A:92:THR:HA	0.58	1.98	16	12
1:A:38:LEU:HG	1:A:59:LEU:HG	0.57	1.76	12	1
1:A:51:THR:OG1	1:A:53:GLN:HG3	0.56	2.00	14	6
1:A:52:GLN:OE1	1:A:68:PHE:HA	0.55	2.02	10	1
1:A:38:LEU:CG	1:A:59:LEU:HG	0.55	2.32	12	2
1:A:46:ILE:CG2	1:A:59:LEU:HD13	0.53	2.33	13	15
1:A:61:THR:HG22	1:A:67:PRO:HG3	0.52	1.81	5	3
1:A:92:THR:HB	1:A:105:ASP:HB2	0.52	1.81	2	2
1:A:42:ASP:HA	1:A:45:LYS:HD3	0.51	1.80	4	5
1:A:93:LEU:HG	1:A:101:LEU:CD2	0.51	2.34	7	10
1:A:92:THR:HB	1:A:105:ASP:HB3	0.51	1.81	15	9
1:A:38:LEU:HD11	1:A:59:LEU:CG	0.51	2.34	7	3
1:A:46:ILE:HD13	1:A:59:LEU:CD2	0.51	2.35	13	4
1:A:38:LEU:HB3	1:A:75:TYR:HB3	0.50	1.84	10	2
1:A:92:THR:O	1:A:105:ASP:HB2	0.49	2.07	4	5
1:A:107:LYS:HE3	1:A:107:LYS:H	0.49	1.68	16	1
1:A:93:LEU:HD23	1:A:95:PHE:CE2	0.49	2.42	18	13
1:A:46:ILE:HA	1:A:50:MET:HE1	0.48	1.85	7	2
1:A:50:MET:HB2	1:A:54:GLN:HG3	0.48	1.86	4	2
1:A:38:LEU:HD13	1:A:42:ASP:HB2	0.48	1.86	7	1
1:A:46:ILE:HG22	1:A:50:MET:HE3	0.47	1.85	13	5
1:A:59:LEU:HD23	1:A:75:TYR:CE2	0.47	2.44	17	5
1:A:40:ALA:HB2	1:A:77:PHE:CG	0.47	2.44	8	2
1:A:43:VAL:HA	1:A:59:LEU:HD11	0.47	1.84	6	1
1:A:39:THR:O	1:A:43:VAL:HG23	0.47	2.09	12	2
1:A:38:LEU:HD11	1:A:59:LEU:CD1	0.47	2.40	7	1
1:A:92:THR:OG1	1:A:107:LYS:HE2	0.47	2.09	1	1
1:A:75:TYR:HB2	1:A:91:LEU:HB3	0.46	1.86	14	6
1:A:42:ASP:O	1:A:45:LYS:HB2	0.46	2.10	4	6
1:A:46:ILE:HG21	1:A:55:VAL:HG13	0.46	1.87	6	1
1:A:38:LEU:HG	1:A:42:ASP:HB2	0.46	1.88	10	2
1:A:62:PRO:CD	1:A:67:PRO:HB3	0.45	2.42	13	1
1:A:53:GLN:HG3	1:A:54:GLN:N	0.45	2.26	13	1
1:A:107:LYS:N	1:A:107:LYS:HE2	0.45	2.27	6	1
1:A:91:LEU:CD1	1:A:104:ILE:HG22	0.44	2.22	14	1
1:A:46:ILE:HD13	1:A:59:LEU:HD22	0.44	1.89	18	11
1:A:93:LEU:HD23	1:A:95:PHE:CZ	0.44	2.48	14	5
1:A:50:MET:HB2	1:A:54:GLN:CG	0.44	2.43	3	3
1:A:76:VAL:HG22	1:A:77:PHE:H	0.44	1.72	12	2
1:A:51:THR:OG1	1:A:53:GLN:HG2	0.44	2.13	13	1
1:A:38:LEU:HD12	1:A:42:ASP:HB3	0.43	1.89	12	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:105:ASP:OD1	1:A:107:LYS:HE3	0.43	2.13	12	1
1:A:50:MET:HB2	1:A:54:GLN:CB	0.43	2.44	8	2
1:A:64:MET:CE	1:A:70:THR:HG21	0.43	2.44	14	1
1:A:76:VAL:HG12	1:A:77:PHE:H	0.42	1.74	10	3
1:A:38:LEU:HG	1:A:39:THR:N	0.42	2.29	1	3
1:A:55:VAL:O	1:A:59:LEU:HB2	0.42	2.14	19	2
1:A:38:LEU:HD23	1:A:75:TYR:HB3	0.42	1.91	19	1
1:A:62:PRO:HD2	1:A:67:PRO:HB3	0.42	1.90	20	1
1:A:38:LEU:CD2	1:A:59:LEU:HG	0.42	2.45	18	2
1:A:53:GLN:HB3	1:A:68:PHE:CZ	0.41	2.50	14	1
1:A:51:THR:OG1	1:A:54:GLN:HG2	0.41	2.15	4	1
1:A:95:PHE:CE1	1:A:101:LEU:HG	0.41	2.51	6	1
1:A:55:VAL:HG13	1:A:59:LEU:HD22	0.41	1.92	13	2
1:A:92:THR:O	1:A:105:ASP:HB3	0.41	2.16	7	1
1:A:61:THR:HA	1:A:62:PRO:HD3	0.41	1.82	20	1
1:A:96:ASN:HB3	1:A:102:THR:HG21	0.40	1.92	3	1
1:A:48:VAL:HG22	1:A:104:ILE:HD11	0.40	1.94	6	2
1:A:98:SER:HB3	1:A:100:VAL:HG23	0.40	1.93	7	1
1:A:72:THR:HA	1:A:93:LEU:O	0.40	2.16	12	1
1:A:56:ALA:HB1	1:A:61:THR:CG2	0.40	2.46	14	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	58/97 (60%)	55±1 (95±2%)	3±1 (4±2%)	0±0 (0±1%)	44	80
All	All	1160/1940 (60%)	1105 (95%)	52 (4%)	3 (0%)	44	80

All 2 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	96	ASN	2
1	A	64	MET	1

6.3.2 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 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	51/84 (61%)	46±1 (89±3%)	6±1 (11±3%)	10	54
All	All	1020/1680 (61%)	910 (89%)	110 (11%)	10	54

All 14 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	47	ARG	20
1	A	48	VAL	20
1	A	59	LEU	20
1	A	107	LYS	11
1	A	53	GLN	9
1	A	77	PHE	8
1	A	63	LEU	6
1	A	64	MET	5
1	A	41	ASN	4
1	A	90	THR	3
1	A	66	ASP	1
1	A	38	LEU	1
1	A	68	PHE	1
1	A	76	VAL	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 monosaccharides 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 (i)

The completeness of assignment taking into account all chemical shift lists is 78% for the well-defined parts and 68% 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 (i)

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	872
Number of shifts mapped to atoms	872
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	0

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	55	-0.04 ± 0.13	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	77	0.07 ± 0.28	None needed (< 0.5 ppm)
$^{13}C'$	0	—	None (insufficient data)
^{15}N	81	0.15 ± 0.24	None needed (< 0.5 ppm)

7.1.3 Completeness of resonance assignments (i)

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 78%, i.e. 605 atoms were assigned a chemical shift out of a possible 772. 0 out of 11 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	209/290 (72%)	118/118 (100%)	35/116 (30%)	56/56 (100%)
Sidechain	364/412 (88%)	244/271 (90%)	114/128 (89%)	6/13 (46%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	32/70 (46%)	16/34 (47%)	15/35 (43%)	1/1 (100%)
Overall	605/772 (78%)	378/423 (89%)	164/279 (59%)	63/70 (90%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 68%, i.e. 872 atoms were assigned a chemical shift out of a possible 1286. 0 out of 16 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	311/484 (64%)	175/198 (88%)	55/194 (28%)	81/92 (88%)
Sidechain	523/698 (75%)	350/454 (77%)	163/214 (76%)	10/30 (33%)
Aromatic	38/104 (37%)	19/50 (38%)	18/49 (37%)	1/5 (20%)
Overall	872/1286 (68%)	544/702 (77%)	236/457 (52%)	92/127 (72%)

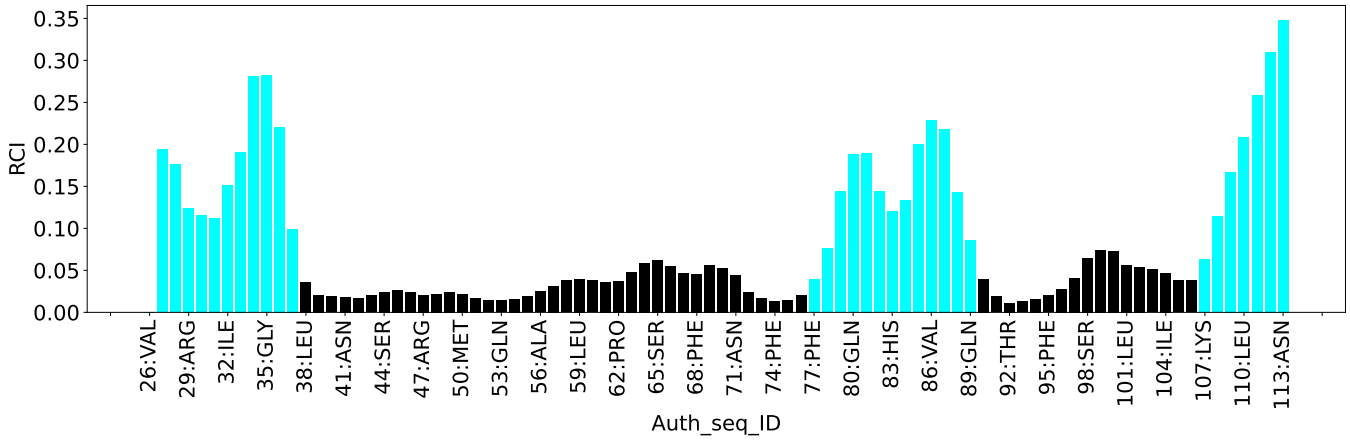
7.1.4 Statistically unusual chemical shifts (i)

There are no statistically unusual chemical shifts.

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:



8 NMR restraints analysis (i)

No restraints data found

9 Distance violation analysis (i)

No distance restraints data found

10 Dihedral-angle violation analysis (i)

Dihedral angle analysis failed due to data error in the dihedral angle restraints, possibly missing target value