Full wwPDB NMR Structure Validation Report (i)

Aug 10, 2021 – 04:05 PM EDT

PDB ID	:	2LFR
Title	:	Solution structure of the chimeric Af1503 HAMP- EnvZ DHp homodimer
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Deposited on	:	2011-07-10

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 following versions of software and data (see references (i)) were used in the production of this report:

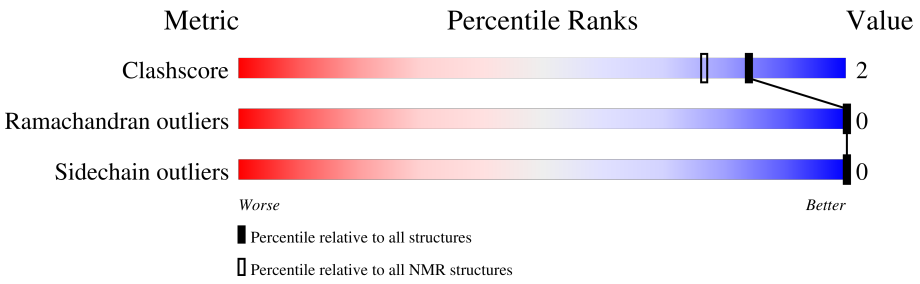
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	2.23.1
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.23.1

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 42%.

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	114	86% 8% • •
1	B	114	83% 10% • •

2 Ensemble composition and analysis (i)

This entry contains 18 models. Model 15 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *minimized average structure*.

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:278-A:384, B:278-B:383 (213)	0.26	15

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 4 single-model clusters were found.

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

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 3544 atoms, of which 1784 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	111	1772	541	892	158	177	4	0
1	B	111	1772	541	892	158	177	4	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	275	MET	-	initiating methionine	UNP O28769
B	275	MET	-	initiating methionine	UNP O28769

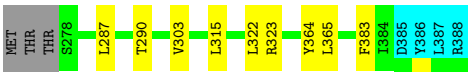
4 Residue-property plots (i)

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.

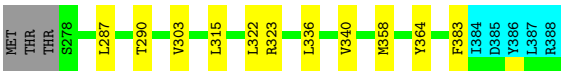
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:



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: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

4.2.2 Score per residue for model 2

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

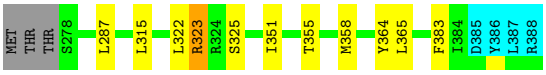
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

4.2.3 Score per residue for model 3

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

4.2.4 Score per residue for model 4

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

4.2.5 Score per residue for model 5

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

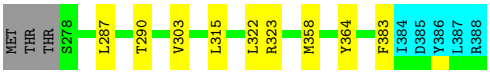
4.2.6 Score per residue for model 6

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:



4.2.7 Score per residue for model 7

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

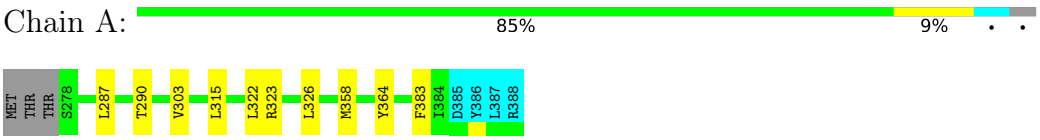
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

4.2.8 Score per residue for model 8

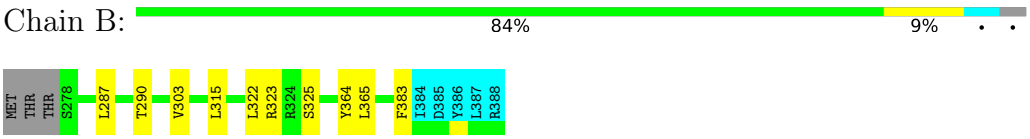
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

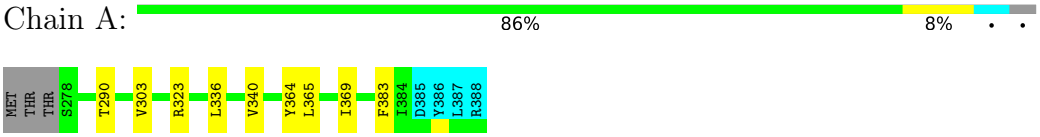
Chain B:



4.2.9 Score per residue for model 9

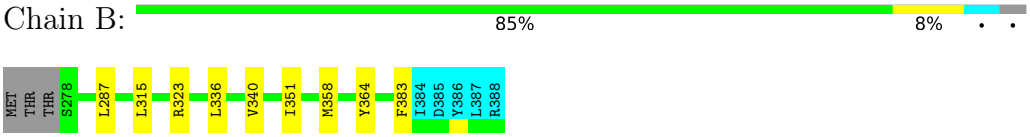
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

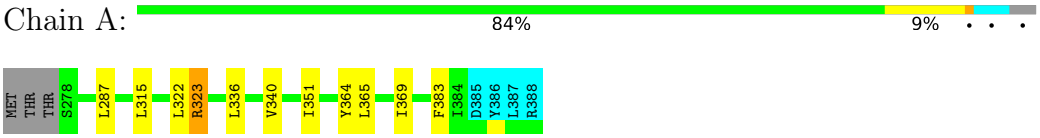
Chain B:



4.2.10 Score per residue for model 10

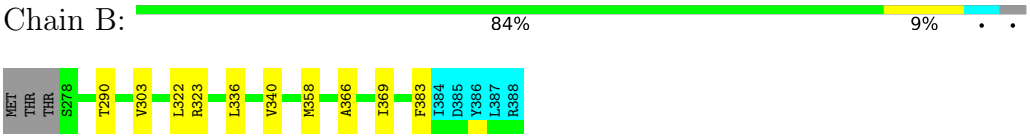
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:



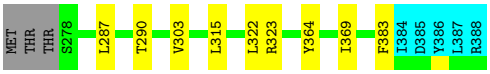
4.2.11 Score per residue for model 11

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

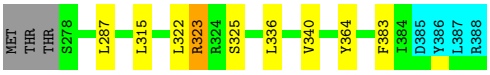
Chain B:



4.2.12 Score per residue for model 12

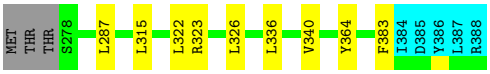
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:



4.2.13 Score per residue for model 13

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

4.2.14 Score per residue for model 14

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A: 84% 10%

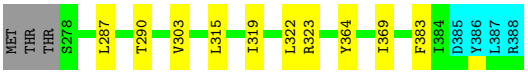
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B: 84% 9%

4.2.15 Score per residue for model 15 (medoid)

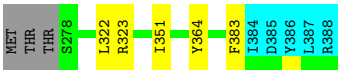
• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A: 85% 9%



• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B: 89%



4.2.16 Score per residue for model 16

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A: 82% 11%

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B: 83% 10%

4.2.17 Score per residue for model 17

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:

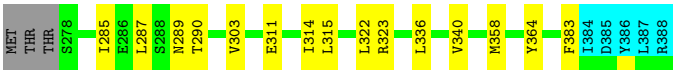
4.2.18 Score per residue for model 18

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain A:

• Molecule 1: HAMP domain-containing protein, Osmolarity sensor protein EnzV chimera

Chain B:



5 Refinement protocol and experimental data overview (i)

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

Of the 50 calculated structures, 18 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
X-PLOR NIH	refinement	2.21
TopSpin	structure solution	
Sparky	structure solution	
X-PLOR NIH	structure solution	2.21

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	1326
Number of shifts mapped to atoms	1326
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	42%

6 Model quality (i)

6.1 Standard geometry (i)

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	0.95±0.05	9±2/847 (1.1± 0.2%)	0.79±0.01	0±0/1143 (0.0± 0.0%)
1	B	0.95±0.05	9±2/839 (1.1± 0.2%)	0.79±0.01	0±0/1132 (0.0± 0.0%)
All	All	0.95	336/30348 (1.1%)	0.79	11/40950 (0.0%)

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	0.9±0.2
1	B	0.0±0.0	0.9±0.2
All	All	0	34

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	364	TYR	CE1-CZ	6.91	1.47	1.38	18	16
1	A	364	TYR	CE2-CZ	6.84	1.47	1.38	12	16
1	B	364	TYR	CE2-CZ	6.83	1.47	1.38	12	16
1	B	364	TYR	CE1-CZ	6.81	1.47	1.38	8	16
1	B	364	TYR	CG-CD1	6.58	1.47	1.39	1	16
1	A	364	TYR	CG-CD1	6.48	1.47	1.39	16	16
1	A	364	TYR	CG-CD2	6.45	1.47	1.39	10	16
1	B	364	TYR	CG-CD2	6.44	1.47	1.39	4	16
1	B	383	PHE	CG-CD1	5.86	1.47	1.38	11	18
1	A	383	PHE	CG-CD1	5.84	1.47	1.38	16	18
1	A	383	PHE	CG-CD2	5.82	1.47	1.38	6	18
1	B	383	PHE	CG-CD2	5.80	1.47	1.38	17	18
1	B	364	TYR	CD1-CE1	5.50	1.47	1.39	11	16
1	A	364	TYR	CD1-CE1	5.49	1.47	1.39	9	16

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)	Models	
								Worst	Total
1	B	364	TYR	CD2-CE2	5.44	1.47	1.39	7	16
1	A	364	TYR	CD2-CE2	5.41	1.47	1.39	13	16
1	B	383	PHE	CE2-CZ	5.37	1.47	1.37	18	18
1	A	383	PHE	CE2-CZ	5.37	1.47	1.37	9	18
1	B	383	PHE	CE1-CZ	5.34	1.47	1.37	2	18
1	A	383	PHE	CE1-CZ	5.34	1.47	1.37	13	18

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(^{o})	Ideal(^{o})	Models	
								Worst	Total
1	A	323	ARG	NE-CZ-NH1	5.51	123.06	120.30	4	8
1	B	323	ARG	NE-CZ-NH1	5.38	122.99	120.30	3	3

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	323	ARG	Sidechain	17
1	B	323	ARG	Sidechain	17

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	840	855	854	5±2
1	B	832	844	843	6±2
All	All	30096	30582	30546	141

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 2.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:287:LEU:HD13	1:A:315:LEU:HD23	0.73	1.58	6	16
1:B:287:LEU:HD13	1:B:315:LEU:HD23	0.68	1.66	17	16
1:A:322:LEU:HD13	1:B:322:LEU:HD13	0.67	1.65	1	15
1:B:336:LEU:O	1:B:340:VAL:HG23	0.63	1.93	4	9
1:A:336:LEU:O	1:A:340:VAL:HG23	0.62	1.94	13	7
1:A:290:THR:HG21	1:A:303:VAL:HA	0.60	1.73	17	9
1:A:376:CYS:HA	1:A:379:ILE:HD12	0.60	1.73	16	1
1:A:326:LEU:HD21	1:B:325:SER:HB2	0.59	1.75	8	1
1:B:358:MET:CE	1:B:366:ALA:HB2	0.58	2.28	10	1
1:A:369:ILE:HG23	1:B:351:ILE:HG23	0.56	1.76	15	6
1:A:351:ILE:HG23	1:B:369:ILE:HG23	0.53	1.80	11	6
1:A:365:LEU:HD13	1:B:358:MET:HG3	0.51	1.81	2	4
1:A:322:LEU:CD1	1:B:322:LEU:HD13	0.51	2.35	18	3
1:B:290:THR:HG21	1:B:303:VAL:HA	0.50	1.83	11	10
1:B:351:ILE:O	1:B:355:THR:HG23	0.50	2.06	17	2
1:A:322:LEU:HD13	1:B:322:LEU:CD1	0.49	2.37	7	4
1:B:287:LEU:CD1	1:B:315:LEU:HD23	0.49	2.37	9	1
1:B:358:MET:HE2	1:B:366:ALA:HB2	0.48	1.82	10	1
1:A:311:GLU:CG	1:B:285:ILE:HD11	0.48	2.38	16	1
1:A:365:LEU:HD13	1:B:358:MET:HG2	0.48	1.86	10	1
1:A:325:SER:HB2	1:B:326:LEU:HD21	0.48	1.84	14	1
1:B:285:ILE:HG22	1:B:289:ASN:ND2	0.47	2.25	16	2
1:A:287:LEU:CD1	1:A:315:LEU:HD23	0.46	2.40	4	2
1:A:326:LEU:HD21	1:B:325:SER:CB	0.44	2.43	4	3
1:A:287:LEU:HD22	1:A:319:ILE:HD12	0.44	1.88	14	1
1:A:351:ILE:O	1:A:355:THR:HG23	0.44	2.13	3	1
1:A:325:SER:CB	1:B:326:LEU:HD21	0.43	2.44	12	3
1:A:358:MET:CG	1:B:365:LEU:HD13	0.43	2.43	3	2
1:B:311:GLU:HA	1:B:314:ILE:HD12	0.42	1.91	18	2
1:A:319:ILE:HA	1:A:322:LEU:HD12	0.42	1.90	15	1
1:A:365:LEU:HD13	1:B:358:MET:CG	0.42	2.44	5	5
1:A:325:SER:HB3	1:B:326:LEU:HD21	0.42	1.91	3	1
1:A:299:LEU:HD13	1:A:327:LYS:HD2	0.41	1.91	6	1
1:A:369:ILE:HD13	1:B:369:ILE:HD13	0.41	1.92	10	1
1:B:370:ASN:O	1:B:373:ILE:HG22	0.40	2.17	1	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	106/114 (93%)	106±0 (100±0%)	0±0 (0±0%)	0±0 (0±0%)	100	100
1	B	105/114 (92%)	104±1 (100±1%)	0±1 (0±1%)	0±0 (0±0%)	100	100
All	All	3798/4104 (93%)	3786 (100%)	12 (0%)	0 (0%)	100	100

There are no Ramachandran outliers.

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	93/100 (93%)	93±0 (100±0%)	0±0 (0±0%)	100	100
1	B	92/100 (92%)	92±0 (100±0%)	0±0 (0±0%)	100	100
All	All	3330/3600 (92%)	3330 (100%)	0 (0%)	100	100

There are no protein residues with a non-rotameric sidechain to report.

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 42% for the well-defined parts and 42% 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	1326
Number of shifts mapped to atoms	1326
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
$^{13}C_{\alpha}$	108	-0.63 ± 0.16	Should be applied
$^{13}C_{\beta}$	103	0.38 ± 0.11	None needed (< 0.5 ppm)
$^{13}C'$	97	-0.47 ± 0.11	None needed (< 0.5 ppm)
^{15}N	100	0.07 ± 0.35	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 42%, i.e. 1118 atoms were assigned a chemical shift out of a possible 2652. 9 out of 28 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	494/1053 (47%)	200/420 (48%)	198/426 (46%)	96/207 (46%)
Sidechain	606/1537 (39%)	363/893 (41%)	232/564 (41%)	11/80 (14%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	18/62 (29%)	14/34 (41%)	3/24 (12%)	1/4 (25%)
Overall	1118/2652 (42%)	577/1347 (43%)	433/1014 (43%)	108/291 (37%)

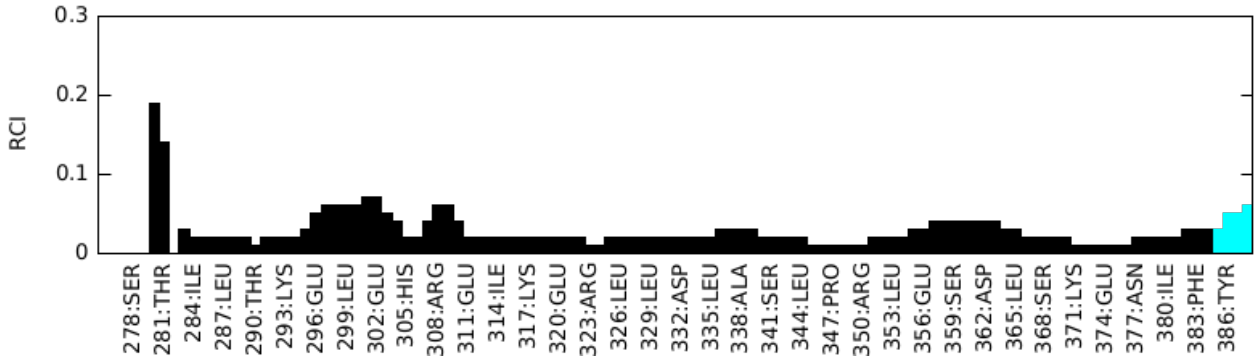
The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 42%, i.e. 1163 atoms were assigned a chemical shift out of a possible 2790. 9 out of 30 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	513/1098 (47%)	208/438 (47%)	205/444 (46%)	100/216 (46%)
Sidechain	626/1614 (39%)	374/938 (40%)	241/590 (41%)	11/86 (13%)
Aromatic	24/78 (31%)	18/42 (43%)	5/32 (16%)	1/4 (25%)
Overall	1163/2790 (42%)	600/1418 (42%)	451/1066 (42%)	112/306 (37%)

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.

Random coil index (RCI) for chain A: