



# Full wwPDB NMR Structure Validation Report ⓘ

Apr 27, 2016 – 04:29 AM BST

PDB ID : 2OV6  
Title : The NMR structure of subunit F of the Methanogenic A1Ao ATP synthase and its interaction with the nucleotide-binding subunit B  
Authors : Gayen, S.; Subramanian, V.; Biukovic, G.  
Deposited on : 2007-02-13

This is a Full wwPDB NMR Structure Validation Report for a publicly released PDB entry.  
We welcome your comments at [validation@mail.wwpdb.org](mailto: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.

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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

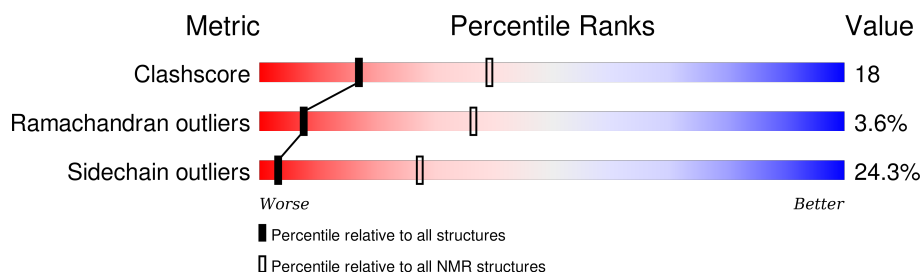
# 1 Overall quality at a glance

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  $\geq 3$ , 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	101	<div> <div></div> <div>42%</div> <div>39%</div> <div>6%</div> <div>14%</div> </div>

## 2 Ensemble composition and analysis ⓘ

This entry contains 10 models. Model 1 is the overall representative, medoid model (most similar to other models).

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:78 (77)	0.50	1
2	A:92-A:101 (10)	0.20	10

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. No single-model clusters were found.

Cluster number	Models
1	1, 2, 7, 9
2	3, 5, 8
3	4, 6, 10

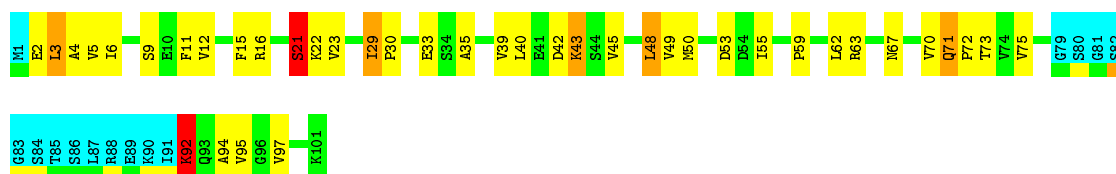
### 3 Entry composition [i](#)

There is only 1 type of molecule in this entry. The entry contains 1534 atoms, of which 779 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called V-type ATP synthase subunit F.

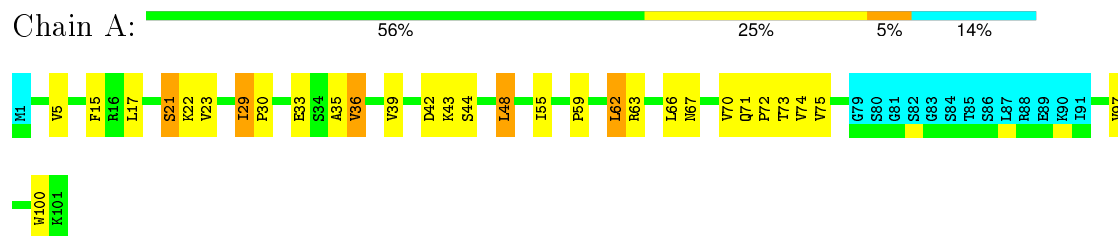
Mol	Chain	Residues	Atoms						Trace
1	A	101	Total	C	H	N	O	S	0
			1534	475	779	129	149	2	





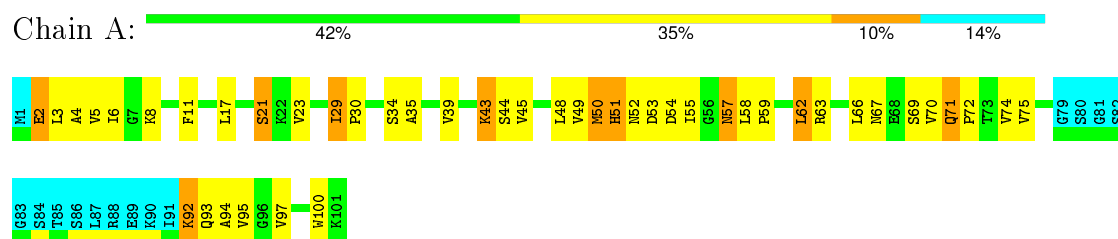
#### 4.2.3 Score per residue for model 3

- Molecule 1: V-type ATP synthase subunit F



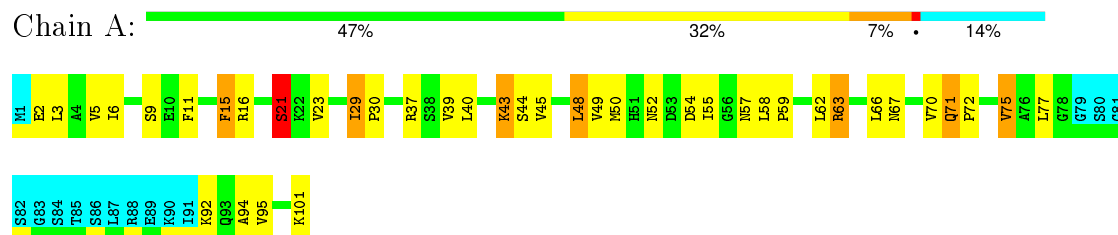
#### 4.2.4 Score per residue for model 4

- Molecule 1: V-type ATP synthase subunit F



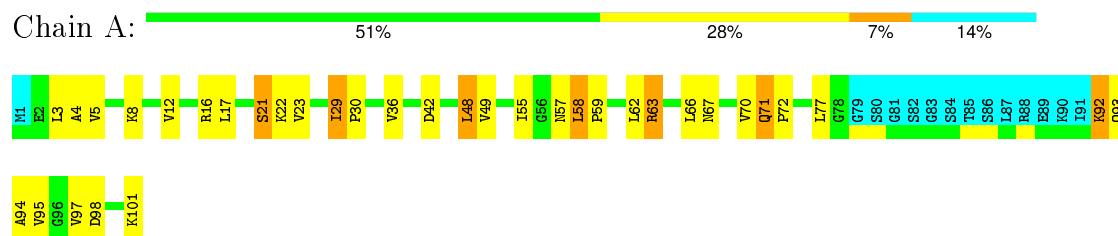
#### 4.2.5 Score per residue for model 5

- Molecule 1: V-type ATP synthase subunit F



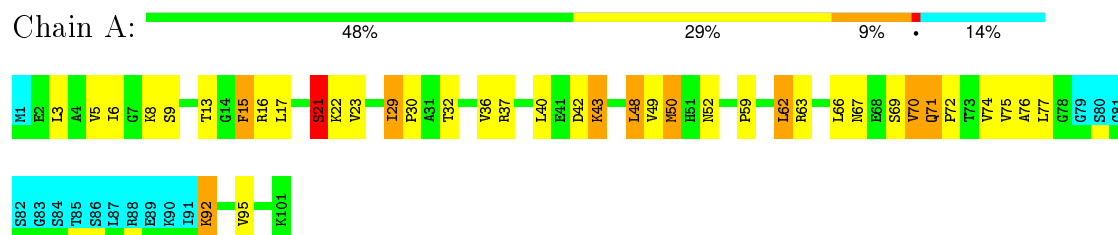
#### 4.2.6 Score per residue for model 6

- Molecule 1: V-type ATP synthase subunit F



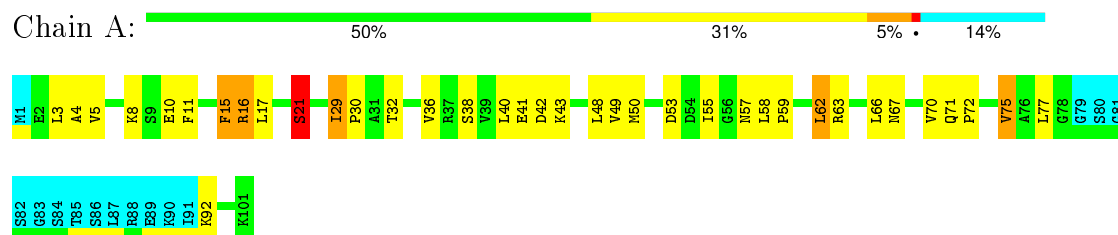
#### 4.2.7 Score per residue for model 7

- Molecule 1: V-type ATP synthase subunit F



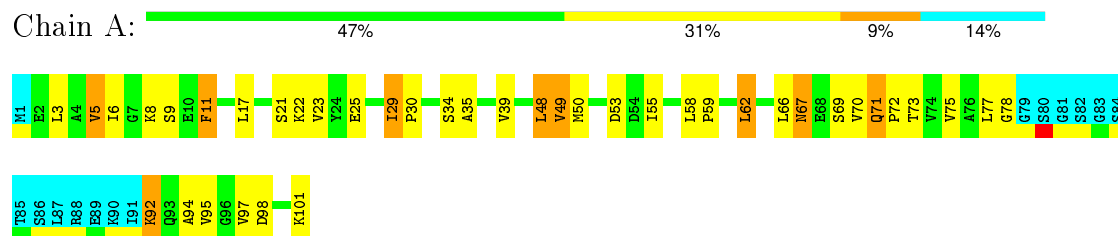
#### 4.2.8 Score per residue for model 8

- Molecule 1: V-type ATP synthase subunit F



#### 4.2.9 Score per residue for model 9

- Molecule 1: V-type ATP synthase subunit F



4.2.10 Score per residue for model 10

- Molecule 1: V-type ATP synthase subunit F





## 5 Refinement protocol and experimental data overview

The models were refined using the following method: *Distance constraints, Simulated annealing, Molecular dynamics, Torsion angle dynamics*.

Of the 100 calculated structures, 10 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

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)	BMRB entry 15046
Number of chemical shift lists	1
Total number of shifts	1179
Number of shifts mapped to atoms	1167
Number of unparsed shifts	0
Number of shifts with mapping errors	12
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.

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

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	659	680	680	24±4
All	All	6590	6800	6800	242

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 18.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:55:ILE:HG23	1:A:62:LEU:HD23	0.85	1.46	5	3
1:A:62:LEU:HD12	1:A:66:LEU:HD23	0.83	1.49	4	5
1:A:6:ILE:HD11	1:A:39:VAL:HG21	0.80	1.50	9	3
1:A:29:ILE:N	1:A:30:PRO:HD2	0.74	1.98	10	10
1:A:36:VAL:HG21	1:A:62:LEU:HD21	0.74	1.58	3	1
1:A:5:VAL:HG13	1:A:49:VAL:HG13	0.69	1.65	6	5
1:A:50:MET:CB	1:A:55:ILE:HD11	0.67	2.19	5	5
1:A:12:VAL:HG23	1:A:23:VAL:HG13	0.66	1.67	6	1
1:A:5:VAL:HB	1:A:49:VAL:HG13	0.65	1.69	9	1
1:A:15:PHE:CD2	1:A:23:VAL:HG21	0.64	2.27	3	3
1:A:29:ILE:N	1:A:30:PRO:CD	0.64	2.61	10	10
1:A:3:LEU:HD23	1:A:21:SER:OG	0.62	1.95	2	1
1:A:97:VAL:HG13	1:A:100:TRP:CZ2	0.61	2.30	3	1
1:A:6:ILE:HD11	1:A:39:VAL:CG2	0.61	2.26	5	2

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:5:VAL:HG22	1:A:49:VAL:CG1	0.61	2.26	7	3
1:A:35:ALA:O	1:A:39:VAL:HG23	0.61	1.96	1	6
1:A:50:MET:HB3	1:A:55:ILE:HD11	0.60	1.73	8	4
1:A:12:VAL:HG23	1:A:23:VAL:CG1	0.60	2.27	6	1
1:A:5:VAL:HG22	1:A:23:VAL:HG22	0.59	1.74	9	1
1:A:42:ASP:OD2	1:A:48:LEU:HD23	0.58	1.98	6	1
1:A:50:MET:CG	1:A:55:ILE:HD11	0.58	2.29	9	1
1:A:94:ALA:O	1:A:97:VAL:HG22	0.58	1.97	4	3
1:A:5:VAL:CB	1:A:49:VAL:HG13	0.58	2.28	9	1
1:A:15:PHE:CG	1:A:16:ARG:N	0.58	2.72	8	3
1:A:50:MET:HB2	1:A:55:ILE:HD11	0.58	1.76	10	3
1:A:50:MET:HE3	1:A:55:ILE:HG21	0.57	1.76	2	1
1:A:42:ASP:O	1:A:48:LEU:HD21	0.57	1.99	6	2
1:A:55:ILE:HG22	1:A:63:ARG:HD3	0.57	1.76	4	5
1:A:5:VAL:CG2	1:A:23:VAL:HG13	0.56	2.31	9	1
1:A:3:LEU:HD12	1:A:4:ALA:N	0.56	2.15	6	2
1:A:5:VAL:CG2	1:A:23:VAL:HG22	0.56	2.31	9	1
1:A:50:MET:SD	1:A:74:VAL:HG12	0.56	2.40	7	1
1:A:12:VAL:HG12	1:A:23:VAL:HG13	0.56	1.78	10	1
1:A:5:VAL:HG13	1:A:49:VAL:HB	0.55	1.79	5	2
1:A:6:ILE:HD12	1:A:50:MET:CG	0.55	2.32	4	1
1:A:48:LEU:N	1:A:48:LEU:HD22	0.54	2.17	1	1
1:A:42:ASP:OD2	1:A:48:LEU:HD22	0.54	2.01	3	1
1:A:92:LYS:O	1:A:95:VAL:HG22	0.54	2.02	5	5
1:A:57:ASN:O	1:A:58:LEU:HD13	0.54	2.02	6	4
1:A:71:GLN:CB	1:A:72:PRO:CD	0.53	2.87	10	10
1:A:55:ILE:CG2	1:A:62:LEU:HD23	0.53	2.34	2	1
1:A:12:VAL:HG12	1:A:23:VAL:CG1	0.53	2.33	2	2
1:A:51:HIS:C	1:A:55:ILE:HD12	0.53	2.23	1	2
1:A:15:PHE:CD1	1:A:21:SER:O	0.52	2.63	5	3
1:A:15:PHE:CD1	1:A:15:PHE:C	0.52	2.82	5	1
1:A:50:MET:SD	1:A:74:VAL:HG13	0.52	2.45	4	1
1:A:5:VAL:HB	1:A:23:VAL:HG13	0.52	1.82	5	5
1:A:2:GLU:OE2	1:A:4:ALA:HB2	0.52	2.05	4	2
1:A:32:THR:O	1:A:36:VAL:HG23	0.52	2.05	8	2
1:A:42:ASP:CG	1:A:48:LEU:HD22	0.52	2.24	3	1
1:A:94:ALA:O	1:A:97:VAL:HG12	0.52	2.05	9	1
1:A:15:PHE:C	1:A:15:PHE:CD1	0.51	2.84	7	2
1:A:2:GLU:HG2	1:A:45:VAL:HG11	0.51	1.83	4	2
1:A:39:VAL:HG13	1:A:48:LEU:HD23	0.50	1.83	5	1
1:A:6:ILE:HD12	1:A:50:MET:HG2	0.50	1.82	10	4

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:55:ILE:HD13	1:A:76:ALA:CB	0.49	2.37	10	1
1:A:58:LEU:HD23	1:A:62:LEU:HD12	0.49	1.85	10	1
1:A:29:ILE:HG13	1:A:58:LEU:HD11	0.48	1.84	10	1
1:A:62:LEU:HG	1:A:66:LEU:HD23	0.48	1.84	5	3
1:A:70:VAL:HG22	1:A:70:VAL:O	0.48	2.09	8	2
1:A:12:VAL:CG1	1:A:23:VAL:HG13	0.48	2.38	10	1
1:A:29:ILE:CD1	1:A:58:LEU:HD11	0.47	2.39	1	1
1:A:5:VAL:HG22	1:A:49:VAL:HG13	0.47	1.86	7	3
1:A:70:VAL:O	1:A:70:VAL:HG22	0.47	2.09	5	5
1:A:92:LYS:O	1:A:95:VAL:HG12	0.47	2.09	2	3
1:A:51:HIS:O	1:A:55:ILE:HD12	0.47	2.09	1	1
1:A:70:VAL:HG13	1:A:70:VAL:O	0.47	2.10	3	2
1:A:4:ALA:HB3	1:A:48:LEU:HD12	0.47	1.87	1	1
1:A:5:VAL:HB	1:A:23:VAL:HG22	0.47	1.84	2	4
1:A:42:ASP:O	1:A:45:VAL:HG12	0.47	2.10	1	1
1:A:40:LEU:HD12	1:A:41:GLU:N	0.46	2.26	8	1
1:A:70:VAL:O	1:A:70:VAL:HG13	0.46	2.11	7	5
1:A:52:ASN:OD1	1:A:76:ALA:HB1	0.46	2.09	7	1
1:A:5:VAL:HG22	1:A:23:VAL:HG13	0.46	1.86	9	1
1:A:57:ASN:C	1:A:58:LEU:HD13	0.46	2.31	6	1
1:A:43:LYS:CA	1:A:48:LEU:HD21	0.45	2.41	5	1
1:A:71:GLN:N	1:A:72:PRO:HD2	0.45	2.27	3	7
1:A:43:LYS:HA	1:A:48:LEU:HD11	0.45	1.88	7	4
1:A:48:LEU:HD22	1:A:48:LEU:N	0.45	2.27	9	1
1:A:49:VAL:HG13	1:A:75:VAL:HB	0.44	1.88	4	3
1:A:66:LEU:C	1:A:66:LEU:HD12	0.44	2.33	4	1
1:A:5:VAL:HG13	1:A:49:VAL:O	0.44	2.13	7	1
1:A:9:SER:O	1:A:12:VAL:HG22	0.43	2.13	10	1
1:A:94:ALA:O	1:A:97:VAL:HG23	0.43	2.13	2	1
1:A:2:GLU:CD	1:A:45:VAL:HG11	0.43	2.34	5	1
1:A:92:LYS:O	1:A:95:VAL:HG13	0.43	2.13	1	1
1:A:15:PHE:HD1	1:A:21:SER:HG	0.43	1.56	10	1
1:A:11:PHE:HB3	1:A:23:VAL:HG11	0.43	1.90	9	1
1:A:29:ILE:HG23	1:A:30:PRO:HD3	0.43	1.90	1	10
1:A:77:LEU:O	1:A:77:LEU:HD12	0.43	2.13	9	1
1:A:40:LEU:C	1:A:40:LEU:HD12	0.43	2.34	1	2
1:A:6:ILE:CD1	1:A:39:VAL:HG21	0.43	2.33	9	1
1:A:43:LYS:HA	1:A:48:LEU:HD21	0.42	1.90	5	3
1:A:2:GLU:HG3	1:A:45:VAL:HG22	0.42	1.91	1	1
1:A:5:VAL:HA	1:A:49:VAL:O	0.42	2.15	2	2
1:A:66:LEU:HD12	1:A:67:ASN:N	0.41	2.30	9	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:51:HIS:CD2	1:A:51:HIS:H	0.41	2.33	4	2
1:A:37:ARG:HA	1:A:40:LEU:HD23	0.41	1.91	7	2
1:A:66:LEU:HD12	1:A:66:LEU:C	0.41	2.36	8	3
1:A:97:VAL:HG13	1:A:100:TRP:HZ2	0.41	1.73	3	1
1:A:48:LEU:HD12	1:A:74:VAL:HG22	0.41	1.92	3	1
1:A:71:GLN:CB	1:A:72:PRO:HD3	0.40	2.45	10	1
1:A:5:VAL:HG12	1:A:49:VAL:CG1	0.40	2.45	9	1
1:A:97:VAL:HG12	1:A:100:TRP:CH2	0.40	2.52	4	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	86/101 (85%)	70±1 (82±1%)	13±1 (15±1%)	3±1 (4±1%)	7	36
All	All	860/1010 (85%)	704 (82%)	125 (15%)	31 (4%)	7	36

All 6 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	59	PRO	10
1	A	21	SER	8
1	A	75	VAL	7
1	A	70	VAL	4
1	A	78	GLY	1
1	A	92	LYS	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	74/85 (87%)	56±3 (76±4%)	18±3 (24±4%)	3	27
All	All	740/850 (87%)	560 (76%)	180 (24%)	3	27

All 46 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	29	ILE	10
1	A	21	SER	10
1	A	67	ASN	10
1	A	92	LYS	8
1	A	17	LEU	8
1	A	48	LEU	7
1	A	71	GLN	7
1	A	63	ARG	7
1	A	22	LYS	6
1	A	8	LYS	6
1	A	11	PHE	6
1	A	43	LYS	5
1	A	77	LEU	5
1	A	69	SER	5
1	A	3	LEU	5
1	A	53	ASP	5
1	A	62	LEU	5
1	A	9	SER	4
1	A	54	ASP	4
1	A	98	ASP	4
1	A	73	THR	4
1	A	13	THR	3
1	A	44	SER	3
1	A	36	VAL	3
1	A	16	ARG	3
1	A	15	PHE	3
1	A	49	VAL	3
1	A	101	LYS	3
1	A	42	ASP	3
1	A	93	GLN	2
1	A	50	MET	2
1	A	51	HIS	2
1	A	52	ASN	2
1	A	58	LEU	2
1	A	33	GLU	2
1	A	34	SER	2

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Mol	Chain	Res	Type	Models (Total)
1	A	25	GLU	2
1	A	57	ASN	1
1	A	6	ILE	1
1	A	26	THR	1
1	A	10	GLU	1
1	A	2	GLU	1
1	A	5	VAL	1
1	A	38	SER	1
1	A	37	ARG	1
1	A	12	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 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 86% for the entire structure.

### 7.1 Chemical shift list 1

File name: BMRB entry 15046

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	1179
Number of shifts mapped to atoms	1167
Number of unparsed shifts	0
Number of shifts with mapping errors	12
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	1

The following assigned chemical shifts were not mapped to the molecules present in the coordinate file.

- Residue not found in structure. All 12 occurrences are reported below.

Chain	Res	Type	Atom	Shift Data		
				Value	Uncertainty	Ambiguity
A	9	PRO	CD	47.88	0.4	1
A	9	PRO	HA	4.193	0.02	1
A	9	PRO	CA	60.95	0.4	1
A	9	PRO	CG	24.54	0.4	1
A	9	PRO	C	174.1	0.4	1
A	9	PRO	HG2	1.762	0.02	1
A	9	PRO	HD3	3.248	0.02	2
A	9	PRO	HG3	1.762	0.02	1
A	9	PRO	HD2	3.493	0.02	2
A	9	PRO	HB3	1.842	0.02	2
A	9	PRO	CB	29.32	0.4	1
A	9	PRO	HB2	2.092	0.02	2



### 7.1.2 Chemical shift referencing ⓘ

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction $\pm$ precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	101	$2.49 \pm 0.08$	Should be applied
$^{13}\text{C}_\beta$	90	$2.98 \pm 0.10$	Should be applied
$^{13}\text{C}'$	95	$2.69 \pm 0.20$	Should be applied
$^{15}\text{N}$	93	$-0.12 \pm 0.41$	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. 919 atoms were assigned a chemical shift out of a possible 1030. 20 out of 22 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	$^1\text{H}$	$^{13}\text{C}$	$^{15}\text{N}$
Backbone	422/427 (99%)	168/170 (99%)	172/174 (99%)	82/83 (99%)
Sidechain	478/558 (86%)	293/321 (91%)	176/216 (81%)	9/21 (43%)
Aromatic	19/45 (42%)	18/24 (75%)	0/19 (0%)	1/2 (50%)
Overall	919/1030 (89%)	479/515 (93%)	348/409 (85%)	92/106 (87%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 86%, i.e. 1018 atoms were assigned a chemical shift out of a possible 1180. 21 out of 23 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	$^1\text{H}$	$^{13}\text{C}$	$^{15}\text{N}$
Backbone	478/497 (96%)	191/198 (96%)	194/202 (96%)	93/97 (96%)
Sidechain	521/638 (82%)	320/369 (87%)	192/244 (79%)	9/25 (36%)
Aromatic	19/45 (42%)	18/24 (75%)	0/19 (0%)	1/2 (50%)
Overall	1018/1180 (86%)	529/591 (90%)	386/465 (83%)	103/124 (83%)

### 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	53	ASP	H	11.52	11.17 – 5.47	5.6

### 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:

