



# Full wwPDB NMR Structure Validation Report ⓘ

Apr 26, 2016 – 08:56 PM BST

PDB ID : 2JMM  
Title : NMR solution structure of a minimal transmembrane beta-barrel platform protein  
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Deposited on : 2006-11-20

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

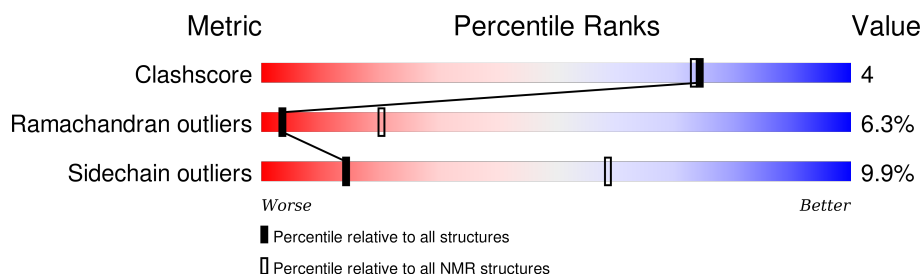
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*SOLUTION NMR*

The overall completeness of chemical shifts assignment is 29%.

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	156	

## 2 Ensemble composition and analysis

This entry contains 10 models. Model 8 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:5-A:47, A:54-A:84, A:103-A:133, A:140-A:150 (116)	1.33	8

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 2 clusters and 1 single-model cluster was found.

Cluster number	Models
1	1, 3, 4, 5, 9
2	6, 7, 8, 10
Single-model clusters	2

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

There is only 1 type of molecule in this entry. The entry contains 2372 atoms, of which 1159 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Outer membrane protein A.

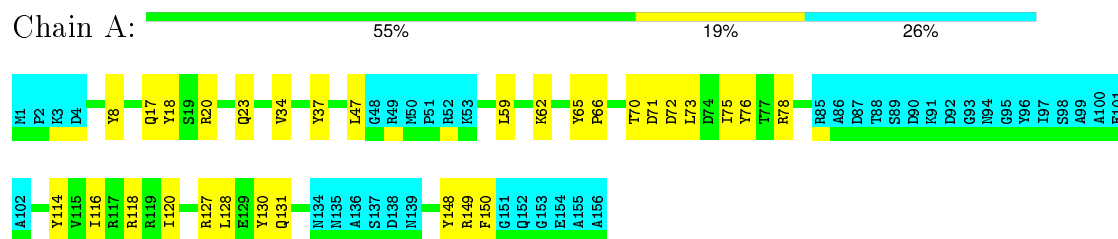
Mol	Chain	Residues	Atoms						Trace
1	A	156	Total	C	H	N	O	S	0
			2372	765	1159	211	232	5	

## 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: Outer membrane protein A

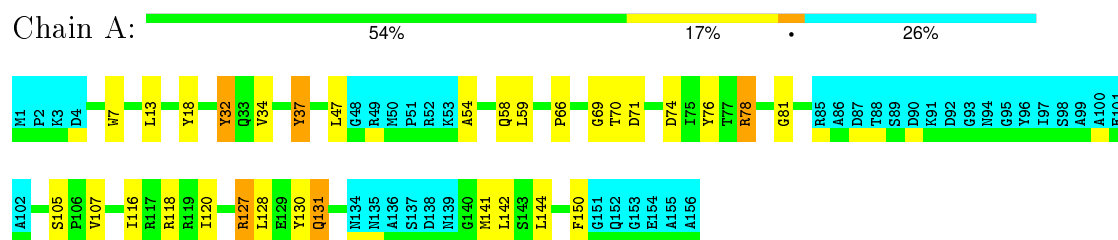


### 4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

#### 4.2.1 Score per residue for model 1

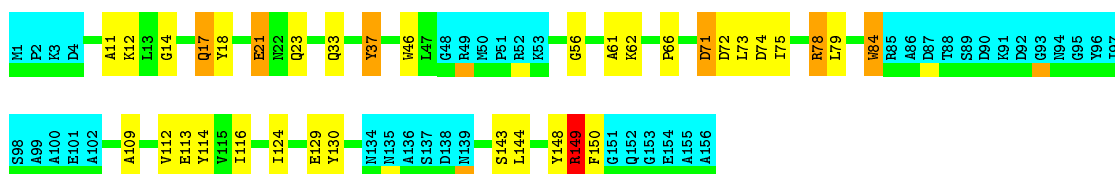
- Molecule 1: Outer membrane protein A



#### 4.2.2 Score per residue for model 2

- Molecule 1: Outer membrane protein A

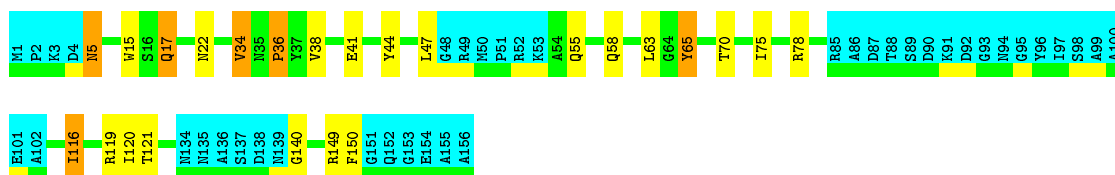




#### 4.2.3 Score per residue for model 3

- Molecule 1: Outer membrane protein A

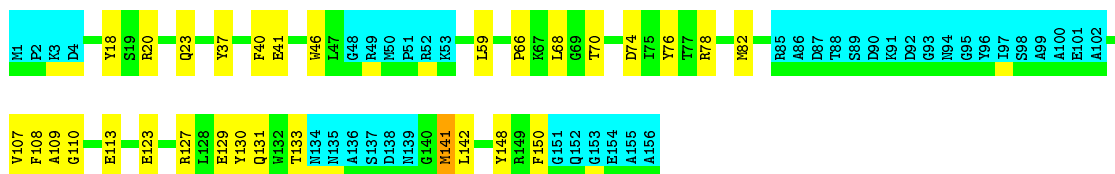
Chain A: 59% 12% 26%



#### 4.2.4 Score per residue for model 4

- Molecule 1: Outer membrane protein A

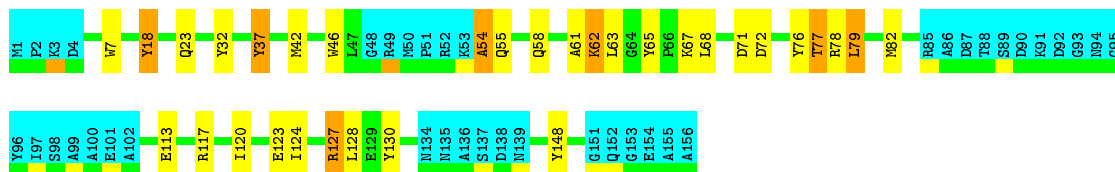
Chain A: 55% 19% 26%



#### 4.2.5 Score per residue for model 5

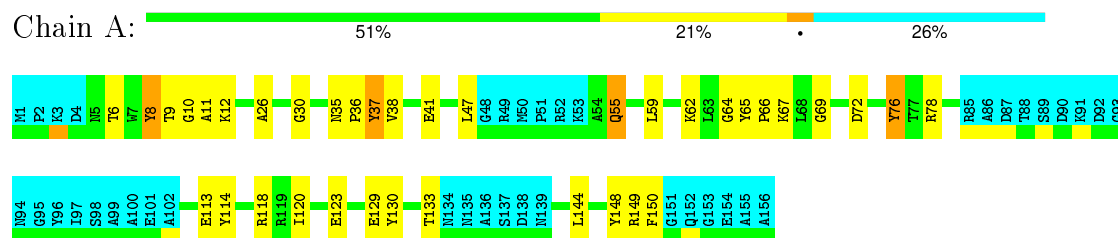
- Molecule 1: Outer membrane protein A

Chain A: 54% 16% 26%



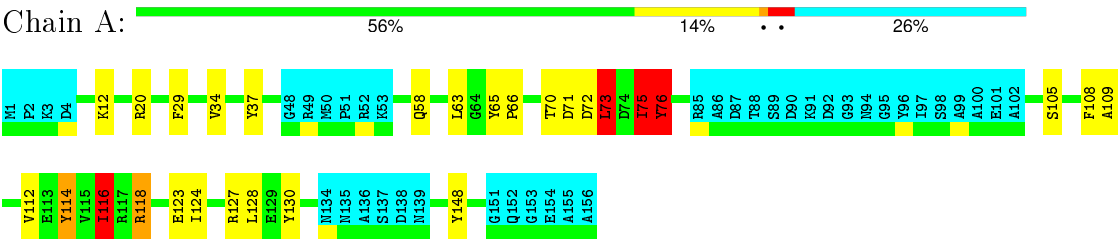
#### 4.2.6 Score per residue for model 6

- Molecule 1: Outer membrane protein A



4.2.10 Score per residue for model 10

- Molecule 1: Outer membrane protein A



## 5 Refinement protocol and experimental data overview

The models were refined using the following method: *torsion angle dynamics, energy minimization*.

Of the 160 calculated structures, 10 were deposited, based on the following criterion: *structures with the lowest energy*.

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

Software name	Classification	Version
CYANA	structure solution	
GROMACS	structure solution	
GROMACS	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)	BMRB entry 15045
Number of chemical shift lists	1
Total number of shifts	528
Number of shifts mapped to atoms	528
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	29%

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

## 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	0.80±0.00	0±0/951 (0.0±0.0%)	1.07±0.02	2±1/1294 (0.1±0.1%)
All	All	0.80	0/9510 (0.0%)	1.07	15/12940 (0.1%)

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	4.5±1.6
All	All	0	45

There are no bond-length outliers.

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	76	TYR	CB-CG-CD2	-6.73	116.96	121.00	7	1
1	A	127	ARG	NE-CZ-NH1	6.08	123.34	120.30	5	2
1	A	65	TYR	CB-CG-CD2	-5.82	117.51	121.00	9	1
1	A	8	TYR	CB-CG-CD2	-5.79	117.53	121.00	6	1
1	A	149	ARG	NE-CZ-NH1	5.40	123.00	120.30	2	1
1	A	78	ARG	NE-CZ-NH1	5.33	122.97	120.30	6	2
1	A	118	ARG	NE-CZ-NH1	5.26	122.93	120.30	10	2
1	A	117	ARG	NE-CZ-NH1	5.23	122.92	120.30	7	1
1	A	37	TYR	CB-CG-CD2	-5.22	117.87	121.00	5	2
1	A	20	ARG	NE-CZ-NH1	5.19	122.89	120.30	7	2

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	76	TYR	Sidechain	7
1	A	130	TYR	Mainchain,Sidechain	5
1	A	65	TYR	Sidechain	4
1	A	148	TYR	Sidechain	3
1	A	114	TYR	Sidechain	3
1	A	32	TYR	Sidechain	2
1	A	71	ASP	Mainchain	2
1	A	18	TYR	Sidechain	2
1	A	75	ILE	Mainchain	2
1	A	8	TYR	Sidechain	2
1	A	11	ALA	Mainchain	2
1	A	77	THR	Mainchain	1
1	A	28	ALA	Mainchain	1
1	A	33	GLN	Mainchain	1
1	A	37	TYR	Sidechain	1
1	A	81	GLY	Mainchain	1
1	A	21	GLU	Mainchain	1
1	A	17	GLN	Mainchain	1
1	A	34	VAL	Mainchain	1
1	A	70	THR	Peptide	1
1	A	120	ILE	Mainchain	1
1	A	73	LEU	Mainchain	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	923	891	891	7±2
All	All	9230	8910	8910	73

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 4.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:7:TRP:HB3	1:A:150:PHE:HA	0.75	1.57	1	1
1:A:61:ALA:O	1:A:78:ARG:HB3	0.72	1.85	5	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:62:LYS:HA	1:A:78:ARG:CB	0.63	2.23	5	1
1:A:46:TRP:HA	1:A:55:GLN:HG3	0.62	1.71	5	1
1:A:15:TRP:HA	1:A:22:ASN:ND2	0.61	2.10	3	1
1:A:63:LEU:O	1:A:76:TYR:HB3	0.60	1.96	7	2
1:A:58:GLN:HE22	1:A:78:ARG:NH1	0.59	1.96	1	1
1:A:123:GLU:O	1:A:148:TYR:HA	0.58	1.98	10	2
1:A:62:LYS:HA	1:A:78:ARG:HB2	0.57	1.76	5	1
1:A:12:LYS:HB3	1:A:144:LEU:O	0.56	2.00	6	2
1:A:149:ARG:HD3	1:A:149:ARG:H	0.56	1.61	2	1
1:A:5:ASN:HA	1:A:34:VAL:HG22	0.54	1.79	3	1
1:A:108:PHE:O	1:A:131:GLN:HB3	0.54	2.02	4	1
1:A:65:TYR:HB2	1:A:75:ILE:HB	0.54	1.78	3	1
1:A:29:PHE:HB3	1:A:42:MET:O	0.54	2.02	8	1
1:A:62:LYS:HG2	1:A:76:TYR:CD2	0.53	2.37	6	1
1:A:61:ALA:O	1:A:78:ARG:HA	0.51	2.05	2	1
1:A:110:GLY:N	1:A:131:GLN:HB2	0.51	2.20	4	1
1:A:81:GLY:HA2	1:A:105:SER:O	0.51	2.06	1	1
1:A:107:VAL:HB	1:A:133:THR:HA	0.51	1.82	4	1
1:A:57:VAL:O	1:A:82:MET:HB3	0.51	2.06	9	1
1:A:131:GLN:HB3	1:A:141:MET:HB2	0.50	1.82	9	1
1:A:26:ALA:O	1:A:45:ASP:HA	0.49	2.07	8	1
1:A:7:TRP:O	1:A:149:ARG:HA	0.49	2.06	9	2
1:A:78:ARG:HB3	1:A:109:ALA:HB3	0.49	1.83	4	1
1:A:38:VAL:HG12	1:A:63:LEU:HG	0.48	1.83	3	1
1:A:78:ARG:HD3	1:A:79:LEU:HD13	0.48	1.85	5	1
1:A:66:PRO:HA	1:A:74:ASP:HA	0.48	1.86	4	2
1:A:5:ASN:HA	1:A:34:VAL:HA	0.47	1.86	7	1
1:A:33:GLN:HE21	1:A:62:LYS:HE3	0.47	1.70	2	1
1:A:131:GLN:HB3	1:A:141:MET:HB3	0.46	1.88	1	1
1:A:72:ASP:O	1:A:114:TYR:HA	0.46	2.11	10	1
1:A:9:THR:HA	1:A:30:GLY:HA2	0.46	1.87	6	1
1:A:38:VAL:HA	1:A:62:LYS:O	0.45	2.11	6	1
1:A:72:ASP:HB2	1:A:114:TYR:CE1	0.45	2.46	6	1
1:A:110:GLY:O	1:A:129:GLU:HA	0.45	2.12	4	1
1:A:117:ARG:HD3	1:A:121:THR:HG21	0.45	1.89	9	1
1:A:74:ASP:HB2	1:A:113:GLU:HB2	0.45	1.89	4	1
1:A:14:GLY:HA2	1:A:143:SER:HA	0.45	1.88	2	1
1:A:56:GLY:HA3	1:A:84:TRP:CD1	0.44	2.48	2	1
1:A:10:GLY:HA2	1:A:148:TYR:CE2	0.44	2.47	6	1
1:A:75:ILE:HB	1:A:112:VAL:HG12	0.44	1.89	10	1
1:A:72:ASP:O	1:A:73:LEU:HB2	0.43	2.13	10	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:58:GLN:HE22	1:A:78:ARG:CZ	0.43	2.26	1	1
1:A:35:ASN:HB3	1:A:38:VAL:O	0.43	2.13	6	1
1:A:59:LEU:N	1:A:82:MET:HB2	0.43	2.29	9	1
1:A:68:LEU:H	1:A:68:LEU:HD23	0.43	1.74	4	1
1:A:129:GLU:HG3	1:A:143:SER:HB3	0.42	1.90	2	1
1:A:47:LEU:HB3	1:A:54:ALA:HB3	0.42	1.90	1	1
1:A:37:TYR:HA	1:A:64:GLY:O	0.42	2.14	6	1
1:A:116:ILE:HB	1:A:124:ILE:O	0.42	2.15	10	1
1:A:35:ASN:H	1:A:36:PRO:CD	0.42	2.27	7	1
1:A:107:VAL:HB	1:A:131:GLN:NE2	0.42	2.29	1	1
1:A:120:ILE:HD12	1:A:120:ILE:H	0.42	1.75	3	1
1:A:67:LYS:HD3	1:A:68:LEU:H	0.42	1.74	5	1
1:A:124:ILE:HG12	1:A:148:TYR:CE2	0.41	2.50	5	1
1:A:73:LEU:HB3	1:A:114:TYR:CE2	0.41	2.51	8	1
1:A:109:ALA:HA	1:A:130:TYR:O	0.41	2.16	2	2
1:A:59:LEU:H	1:A:82:MET:HB2	0.41	1.75	9	1
1:A:62:LYS:HD3	1:A:127:ARG:HH21	0.41	1.75	8	1
1:A:6:THR:HA	1:A:149:ARG:HB3	0.40	1.91	6	1
1:A:123:GLU:HB2	1:A:148:TYR:CZ	0.40	2.52	4	1
1:A:6:THR:HA	1:A:150:PHE:CZ	0.40	2.51	8	1
1:A:66:PRO:HA	1:A:74:ASP:OD2	0.40	2.17	1	1
1:A:63:LEU:HG	1:A:77:THR:O	0.40	2.17	5	1
1:A:6:THR:HB	1:A:8:TYR:CE2	0.40	2.52	7	1
1:A:75:ILE:HG22	1:A:112:VAL:HG22	0.40	1.93	2	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	116/156 (74%)	96±4 (82±3%)	13±3 (11±3%)	7±2 (6±2%)	3	20
All	All	1160/1560 (74%)	957 (82%)	130 (11%)	73 (6%)	3	20

All 34 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	37	TYR	7
1	A	150	PHE	5
1	A	116	ILE	4
1	A	120	ILE	4
1	A	118	ARG	3
1	A	66	PRO	3
1	A	71	ASP	3
1	A	23	GLN	3
1	A	72	ASP	3
1	A	70	THR	3
1	A	20	ARG	3
1	A	18	TYR	2
1	A	121	THR	2
1	A	34	VAL	2
1	A	55	GLN	2
1	A	54	ALA	2
1	A	69	GLY	2
1	A	133	THR	2
1	A	17	GLN	2
1	A	25	GLY	2
1	A	8	TYR	1
1	A	73	LEU	1
1	A	35	ASN	1
1	A	26	ALA	1
1	A	117	ARG	1
1	A	140	GLY	1
1	A	22	ASN	1
1	A	5	ASN	1
1	A	67	LYS	1
1	A	123	GLU	1
1	A	65	TYR	1
1	A	47	LEU	1
1	A	21	GLU	1
1	A	36	PRO	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	92/120 (77%)	83±3 (90±3%)	9±3 (10±3%)	14	59
All	All	920/1200 (77%)	829 (90%)	91 (10%)	14	59

All 49 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	128	LEU	5
1	A	59	LEU	5
1	A	73	LEU	4
1	A	127	ARG	4
1	A	118	ARG	3
1	A	113	GLU	3
1	A	82	MET	3
1	A	142	LEU	3
1	A	41	GLU	3
1	A	47	LEU	3
1	A	58	GLN	3
1	A	76	TYR	2
1	A	13	LEU	2
1	A	116	ILE	2
1	A	37	TYR	2
1	A	42	MET	2
1	A	78	ARG	2
1	A	79	LEU	2
1	A	12	LYS	2
1	A	149	ARG	2
1	A	23	GLN	2
1	A	131	GLN	2
1	A	144	LEU	2
1	A	84	TRP	2
1	A	65	TYR	2
1	A	44	TYR	1
1	A	18	TYR	1
1	A	62	LYS	1
1	A	46	TRP	1
1	A	75	ILE	1
1	A	55	GLN	1
1	A	29	PHE	1
1	A	33	GLN	1
1	A	40	PHE	1
1	A	32	TYR	1
1	A	148	TYR	1

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Mol	Chain	Res	Type	Models (Total)
1	A	141	MET	1
1	A	119	ARG	1
1	A	70	THR	1
1	A	150	PHE	1
1	A	74	ASP	1
1	A	124	ILE	1
1	A	120	ILE	1
1	A	17	GLN	1
1	A	21	GLU	1
1	A	129	GLU	1
1	A	105	SER	1
1	A	108	PHE	1
1	A	5	ASN	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 [i](#)

The completeness of assignment taking into account all chemical shift lists is 29% for the well-defined parts and 28% for the entire structure.

### 7.1 Chemical shift list 1

File name: BMRB entry 15045

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	528
Number of shifts mapped to atoms	528
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 $\pm$ precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	111	$0.77 \pm 0.08$	Should be applied
$^{13}\text{C}_\beta$	91	$0.18 \pm 0.16$	None needed ( $< 0.5$ ppm)
$^{13}\text{C}'$	106	$1.03 \pm 0.22$	Should be applied
$^{15}\text{N}$	110	$-0.23 \pm 0.54$	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 29%, i.e. 413 atoms were assigned a chemical shift out of a possible 1415. 0 out of 20 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	$^1\text{H}$	$^{13}\text{C}$	$^{15}\text{N}$
Backbone	341/572 (60%)	86/228 (38%)	169/232 (73%)	86/112 (77%)
Sidechain	72/667 (11%)	0/391 (0%)	72/243 (30%)	0/33 (0%)

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	Total	<sup>1</sup> H	<sup>13</sup> C	<sup>15</sup> N
Aromatic	0/176 (0%)	0/90 (0%)	0/81 (0%)	0/5 (0%)
Overall	413/1415 (29%)	86/709 (12%)	241/556 (43%)	86/150 (57%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 28%, i.e. 528 atoms were assigned a chemical shift out of a possible 1857. 0 out of 20 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	<sup>1</sup> H	<sup>13</sup> C	<sup>15</sup> N
Backbone	437/768 (57%)	110/306 (36%)	217/312 (70%)	110/150 (73%)
Sidechain	91/905 (10%)	0/532 (0%)	91/323 (28%)	0/50 (0%)
Aromatic	0/184 (0%)	0/94 (0%)	0/85 (0%)	0/5 (0%)
Overall	528/1857 (28%)	110/932 (12%)	308/720 (43%)	110/205 (54%)

#### 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:

