



# Full wwPDB NMR Structure Validation Report ⓘ

Apr 26, 2016 – 03:30 PM BST

PDB ID : 1K9C  
Title : Solution Structure of Calreticulin P-domain subdomain (residues 189-261)  
Authors : Ellgaard, L.; Bettendorff, P.; Braun, D.; Herrmann, T.; Fiorito, F.; Guntert, P.; Helenius, A.; Wuthrich, K.  
Deposited on : 2001-10-29

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.

---

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

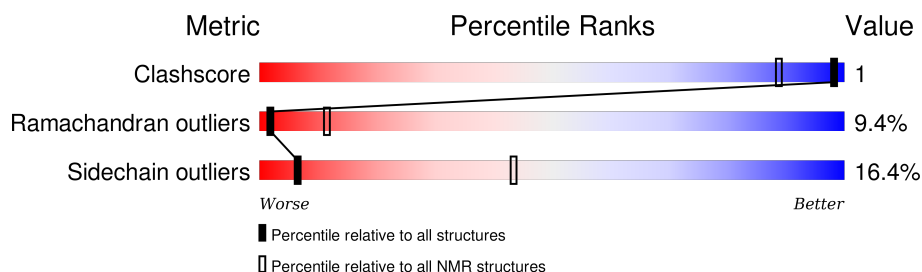
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*SOLUTION NMR*

The overall completeness of chemical shifts assignment is 84%.

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	74	 66% 15% 19%

## 2 Ensemble composition and analysis ⓘ

This entry contains 20 models. Model 13 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *closest to the average*.

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:195-A:206 (12)	1.19	13
2	A:214-A:261 (48)	0.71	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 1 single-model cluster was found.

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

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

There is only 1 type of molecule in this entry. The entry contains 1179 atoms, of which 560 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called CALRETICULIN.

Mol	Chain	Residues	Atoms						Trace
1	A	74	Total	C	H	N	O	S	0
			1179	388	560	100	130	1	

There is a discrepancy between the modelled and reference sequences:

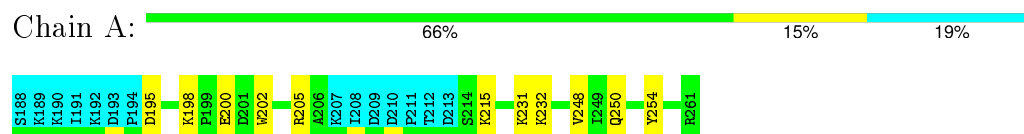
Chain	Residue	Modelled	Actual	Comment	Reference
A	188	SER	-	CLONING ARTIFACT	UNP P18418

## 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: CALRETICULIN

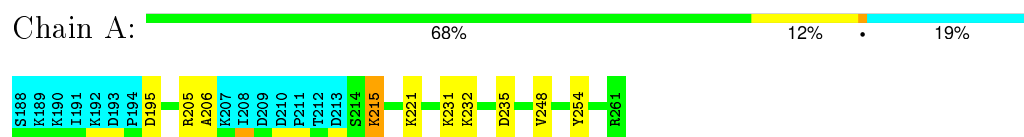


### 4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

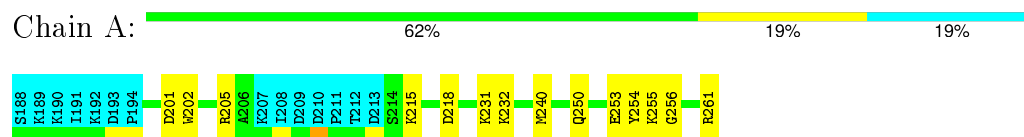
#### 4.2.1 Score per residue for model 1

- Molecule 1: CALRETICULIN



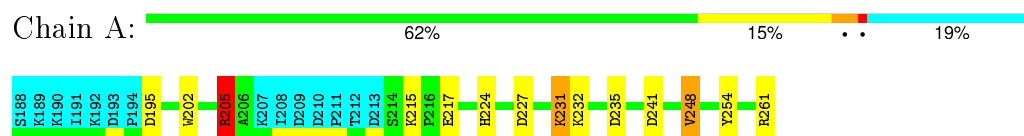
#### 4.2.2 Score per residue for model 2

- Molecule 1: CALRETICULIN



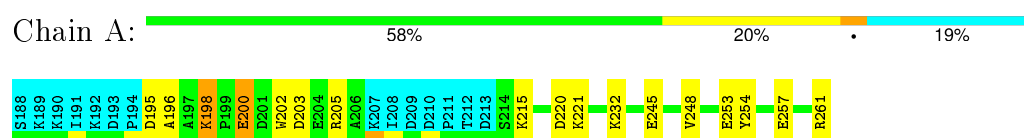
### 4.2.3 Score per residue for model 3

- Molecule 1: CALRETICULIN



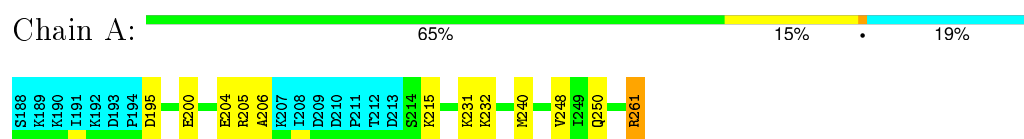
### 4.2.4 Score per residue for model 4

- Molecule 1: CALRETICULIN



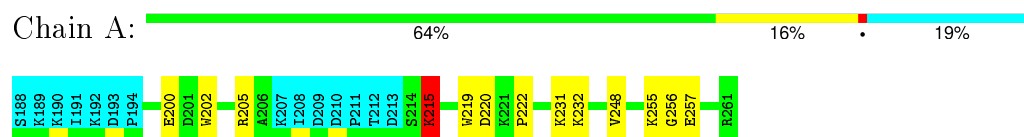
### 4.2.5 Score per residue for model 5

- Molecule 1: CALRETICULIN



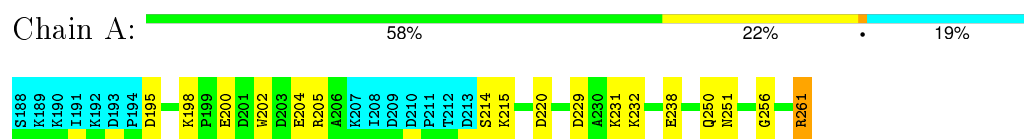
### 4.2.6 Score per residue for model 6

- Molecule 1: CALRETICULIN



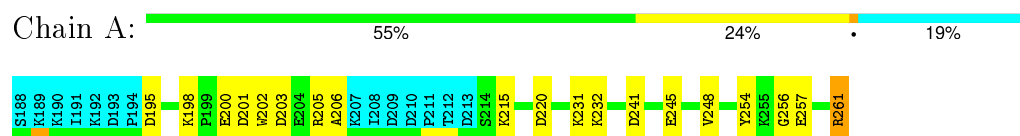
### 4.2.7 Score per residue for model 7

- Molecule 1: CALRETICULIN



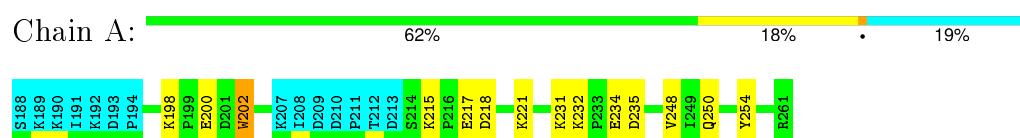
### 4.2.8 Score per residue for model 8

- Molecule 1: CALRETICULIN



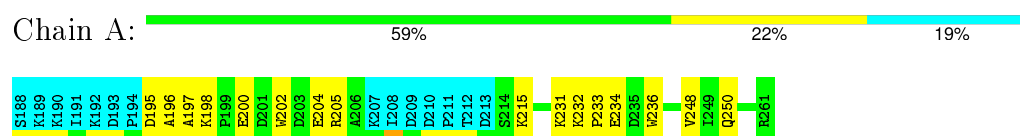
### 4.2.9 Score per residue for model 9

- Molecule 1: CALRETICULIN



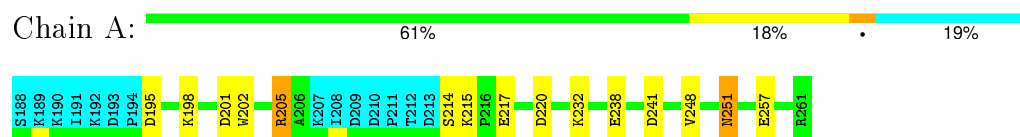
### 4.2.10 Score per residue for model 10

- Molecule 1: CALRETICULIN



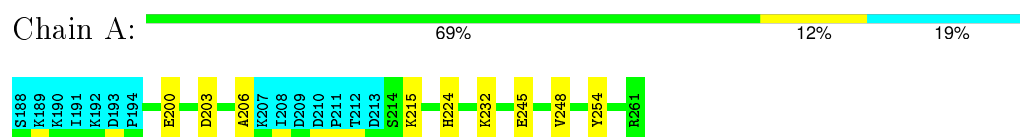
### 4.2.11 Score per residue for model 11

- Molecule 1: CALRETICULIN



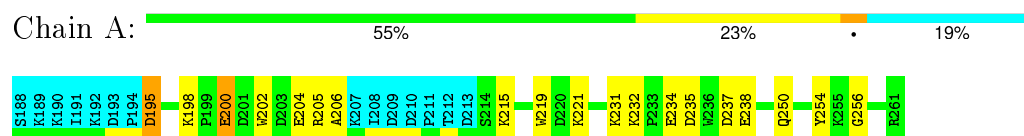
### 4.2.12 Score per residue for model 12

- Molecule 1: CALRETICULIN



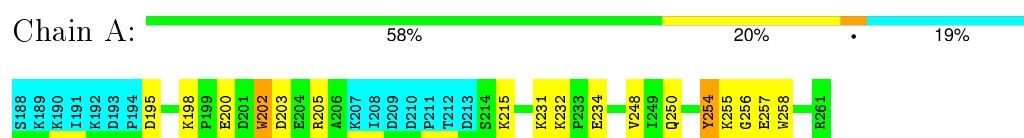
### 4.2.13 Score per residue for model 13 (medoid)

- Molecule 1: CALRETICULIN



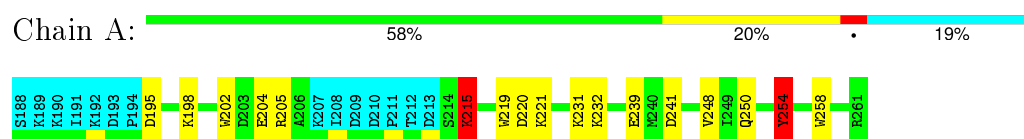
### 4.2.14 Score per residue for model 14

- Molecule 1: CALRETICULIN



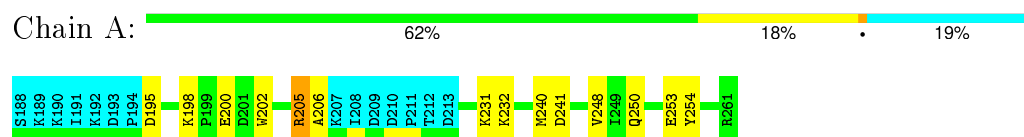
### 4.2.15 Score per residue for model 15

- Molecule 1: CALRETICULIN



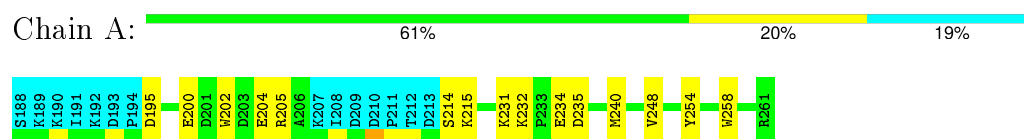
### 4.2.16 Score per residue for model 16

- Molecule 1: CALRETICULIN



### 4.2.17 Score per residue for model 17

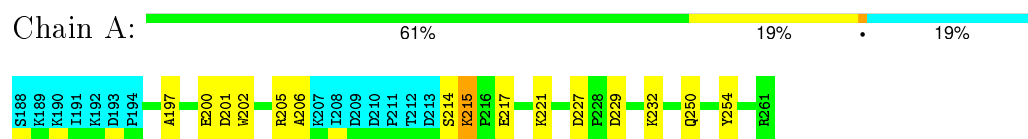
- Molecule 1: CALRETICULIN





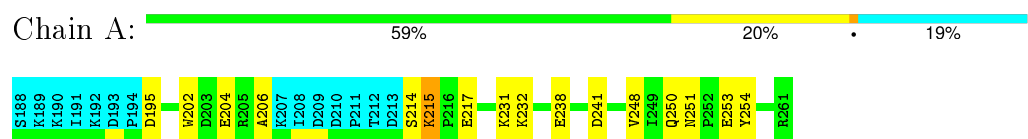
### 4.2.18 Score per residue for model 18

- Molecule 1: CALRETICULIN



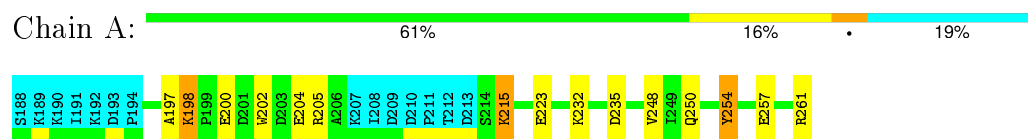
### 4.2.19 Score per residue for model 19

- Molecule 1: CALRETICULIN



### 4.2.20 Score per residue for model 20

- Molecule 1: CALRETICULIN



## 5 Refinement protocol and experimental data overview

The models were refined using the following method: *torsion angle dynamics, simulated annealing*.

Of the 100 calculated structures, 20 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	1.68
DYANA	refinement	1.68

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 5204
Number of chemical shift lists	1
Total number of shifts	834
Number of shifts mapped to atoms	834
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	84%

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	0.63±0.01	0±0/529 (0.0±0.0%)	1.18±0.04	0±1/723 (0.1±0.1%)
All	All	0.63	0/10580 (0.0%)	1.18	9/14460 (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	0.8±0.8
All	All	0	17

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	227	ASP	CB-CG-OD2	-5.58	113.28	118.30	3	1
1	A	237	ASP	C-N-CA	5.56	135.60	121.70	13	1
1	A	261	ARG	CB-CA-C	5.50	121.41	110.40	5	1
1	A	261	ARG	NE-CZ-NH2	-5.38	117.61	120.30	3	2
1	A	197	ALA	C-N-CA	5.38	135.15	121.70	20	1
1	A	254	TYR	CB-CG-CD2	-5.37	117.78	121.00	14	1
1	A	205	ARG	NE-CZ-NH2	-5.03	117.79	120.30	3	1
1	A	202	TRP	CA-CB-CG	5.03	123.25	113.70	14	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	200	GLU	Peptide	4
1	A	205	ARG	Sidechain	3
1	A	261	ARG	Sidechain	2
1	A	255	LYS	Peptide	2
1	A	254	TYR	Sidechain	2
1	A	234	GLU	Peptide	1
1	A	222	PRO	Peptide	1
1	A	253	GLU	Peptide	1
1	A	256	GLY	Peptide	1

## 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	508	444	444	0±1
All	All	10160	8880	8880	10

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 1.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:224:HIS:HB3	1:A:248:VAL:HG21	0.81	1.48	12	2
1:A:231:LYS:HE2	1:A:231:LYS:HA	0.50	1.83	3	1
1:A:224:HIS:CB	1:A:248:VAL:HG21	0.49	2.32	3	2
1:A:217:GLU:H	1:A:217:GLU:CD	0.48	2.10	11	1
1:A:219:TRP:CZ2	1:A:258:TRP:HA	0.48	2.44	15	1
1:A:214:SER:HA	1:A:258:TRP:CZ2	0.47	2.44	17	1
1:A:215:LYS:HD3	1:A:219:TRP:CD1	0.42	2.49	15	2

## 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	59/74 (80%)	43±2 (72±3%)	11±2 (18±4%)	6±2 (9±3%)	2	11
All	All	1180/1480 (80%)	853 (72%)	216 (18%)	111 (9%)	2	11

All 24 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	232	LYS	20
1	A	215	LYS	18
1	A	254	TYR	14
1	A	200	GLU	10
1	A	206	ALA	8
1	A	195	ASP	8
1	A	256	GLY	5
1	A	203	ASP	3
1	A	251	ASN	2
1	A	220	ASP	2
1	A	204	GLU	2
1	A	198	LYS	2
1	A	217	GLU	2
1	A	197	ALA	2
1	A	253	GLU	2
1	A	214	SER	2
1	A	196	ALA	2
1	A	202	TRP	1
1	A	205	ARG	1
1	A	257	GLU	1
1	A	238	GLU	1
1	A	255	LYS	1
1	A	236	TRP	1
1	A	233	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	54/68 (79%)	45±3 (84±5%)	9±3 (16±5%)	6	43
All	All	1080/1360 (79%)	903 (84%)	177 (16%)	6	43

All 34 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	202	TRP	17
1	A	205	ARG	16
1	A	231	LYS	15
1	A	248	VAL	15
1	A	250	GLN	12
1	A	198	LYS	11
1	A	215	LYS	7
1	A	195	ASP	7
1	A	241	ASP	6
1	A	204	GLU	6
1	A	221	LYS	6
1	A	235	ASP	6
1	A	261	ARG	5
1	A	257	GLU	5
1	A	201	ASP	4
1	A	220	ASP	4
1	A	240	MET	4
1	A	234	GLU	4
1	A	238	GLU	3
1	A	245	GLU	3
1	A	200	GLU	2
1	A	254	TYR	2
1	A	251	ASN	2
1	A	217	GLU	2
1	A	218	ASP	2
1	A	214	SER	2
1	A	229	ASP	2
1	A	258	TRP	1
1	A	223	GLU	1
1	A	227	ASP	1
1	A	253	GLU	1
1	A	219	TRP	1
1	A	239	GLU	1
1	A	203	ASP	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 84% for the well-defined parts and 84% for the entire structure.

### 7.1 Chemical shift list 1

File name: BMRB entry 5204

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	834
Number of shifts mapped to atoms	834
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
$^{13}\text{C}_\alpha$	73	$0.74 \pm 0.14$	Should be applied
$^{13}\text{C}_\beta$	72	$0.03 \pm 0.10$	None needed ( $< 0.5$ ppm)
$^{13}\text{C}'$	0	—	—
$^{15}\text{N}$	61	$-1.25 \pm 0.34$	Should be applied

#### 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 84%, i.e. 647 atoms were assigned a chemical shift out of a possible 770. 1 out of 1 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	$^1\text{H}$	$^{13}\text{C}$	$^{15}\text{N}$
Backbone	219/280 (78%)	110/110 (100%)	59/120 (49%)	50/50 (100%)
Sidechain	368/415 (89%)	240/250 (96%)	124/150 (83%)	4/15 (27%)

*Continued on next page...*



Continued from previous page...

	Total	<sup>1</sup> H	<sup>13</sup> C	<sup>15</sup> N
Aromatic	60/75 (80%)	31/38 (82%)	24/31 (77%)	5/6 (83%)
Overall	647/770 (84%)	381/398 (96%)	207/301 (69%)	59/71 (83%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 84%, i.e. 798 atoms were assigned a chemical shift out of a possible 947. 1 out of 1 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	<sup>1</sup> H	<sup>13</sup> C	<sup>15</sup> N
Backbone	269/346 (78%)	135/136 (99%)	73/148 (49%)	61/62 (98%)
Sidechain	469/526 (89%)	305/316 (97%)	160/191 (84%)	4/19 (21%)
Aromatic	60/75 (80%)	31/38 (82%)	24/31 (77%)	5/6 (83%)
Overall	798/947 (84%)	471/490 (96%)	257/370 (69%)	70/87 (80%)

#### 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:

