



# Full wwPDB NMR Structure Validation Report ⓘ

Mar 6, 2022 – 06:57 PM EST

PDB ID : 2RML  
Title : Solution structure of the N-terminal soluble domains of Bacillus subtilis CopA  
Authors : Singleton, C.; Banci, L.; Bertini, I.; Ciofi-Baffoni, S.; Tenori, L.; Kihlken, M.A.; Boetzel, R.; Le Brun, N.E.  
Deposited on : 2007-10-30

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

<https://www.wwpdb.org/validation/2017/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:

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 : 2.27  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.27

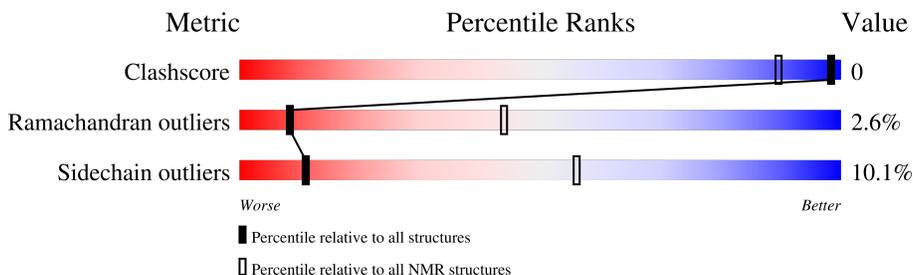
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*SOLUTION NMR*

The overall completeness of chemical shifts assignment was not calculated.

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  $\geq 3$ , 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	147	 91% 6% .

## 2 Ensemble composition and analysis

This entry contains 25 models. Model 25 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:147 (143)	0.62	25

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 4 clusters and 1 single-model cluster was found.

Cluster number	Models
1	2, 7, 10, 12, 13, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25
2	4, 5, 9, 17
3	3, 8, 19
4	1, 11
Single-model clusters	6

### 3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 2233 atoms, of which 1124 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Copper-transporting P-type ATPase copA.

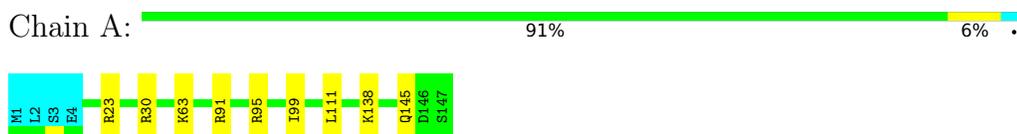
Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	147	2233	687	1124	187	226	9	0

## 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: Copper-transporting P-type ATPase copA

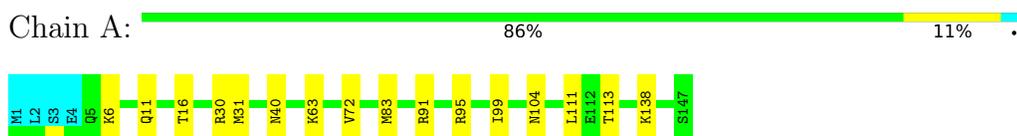


### 4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

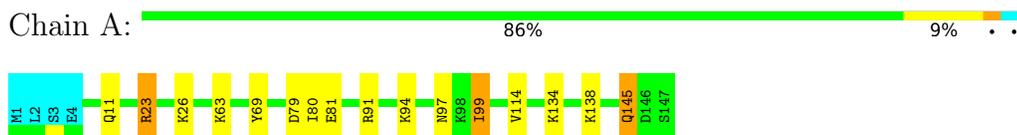
#### 4.2.1 Score per residue for model 1

- Molecule 1: Copper-transporting P-type ATPase copA



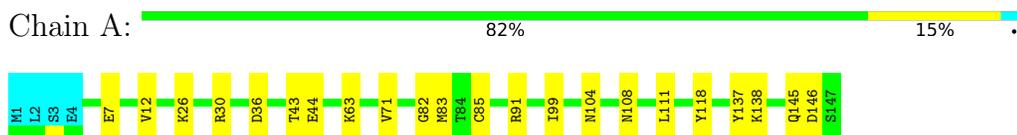
#### 4.2.2 Score per residue for model 2

- Molecule 1: Copper-transporting P-type ATPase copA



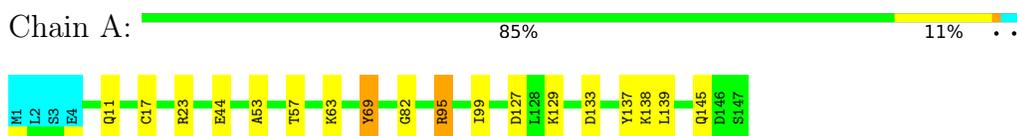
### 4.2.3 Score per residue for model 3

- Molecule 1: Copper-transporting P-type ATPase copA



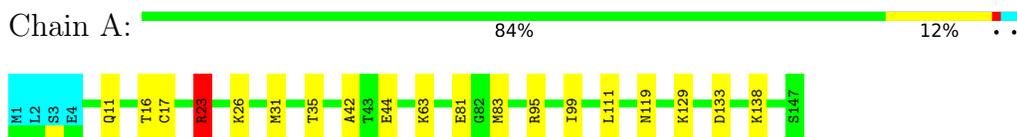
### 4.2.4 Score per residue for model 4

- Molecule 1: Copper-transporting P-type ATPase copA



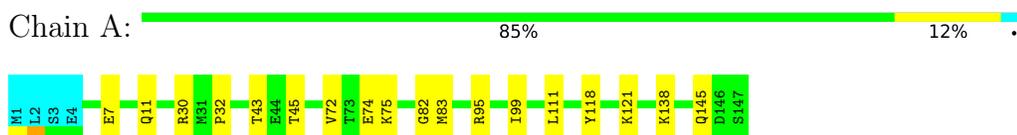
### 4.2.5 Score per residue for model 5

- Molecule 1: Copper-transporting P-type ATPase copA



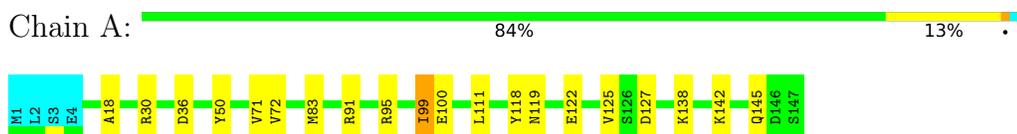
### 4.2.6 Score per residue for model 6

- Molecule 1: Copper-transporting P-type ATPase copA



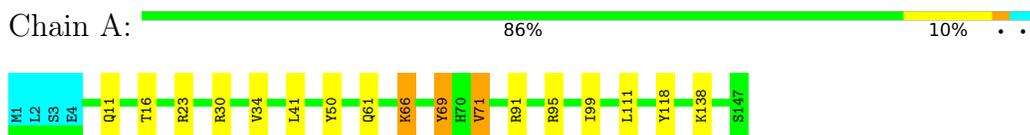
### 4.2.7 Score per residue for model 7

- Molecule 1: Copper-transporting P-type ATPase copA



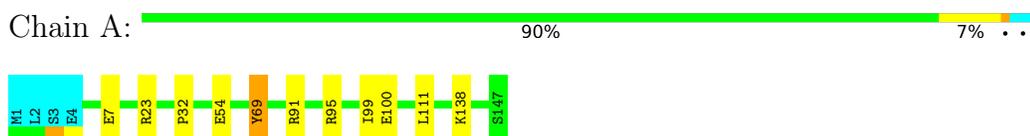
#### 4.2.8 Score per residue for model 8

- Molecule 1: Copper-transporting P-type ATPase copA



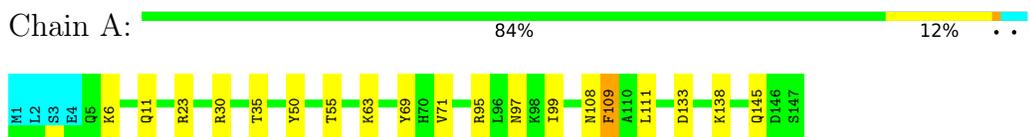
#### 4.2.9 Score per residue for model 9

- Molecule 1: Copper-transporting P-type ATPase copA



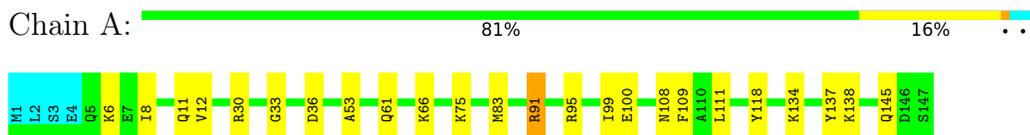
#### 4.2.10 Score per residue for model 10

- Molecule 1: Copper-transporting P-type ATPase copA



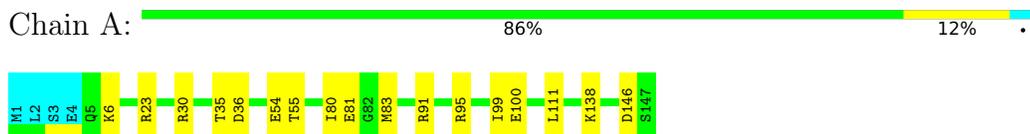
#### 4.2.11 Score per residue for model 11

- Molecule 1: Copper-transporting P-type ATPase copA



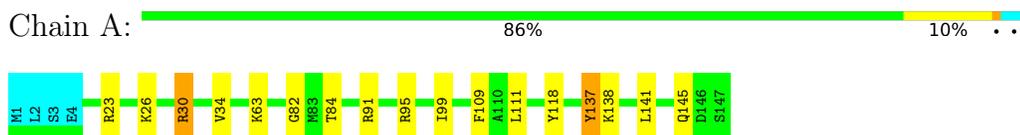
#### 4.2.12 Score per residue for model 12

- Molecule 1: Copper-transporting P-type ATPase copA



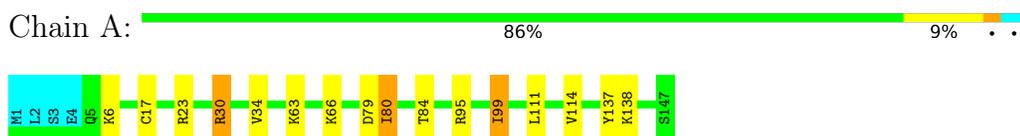
### 4.2.13 Score per residue for model 13

- Molecule 1: Copper-transporting P-type ATPase copA



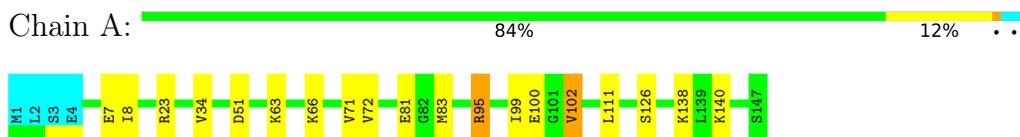
### 4.2.14 Score per residue for model 14

- Molecule 1: Copper-transporting P-type ATPase copA



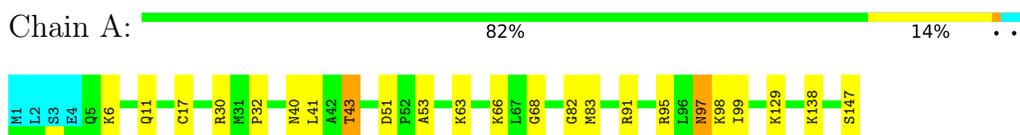
### 4.2.15 Score per residue for model 15

- Molecule 1: Copper-transporting P-type ATPase copA



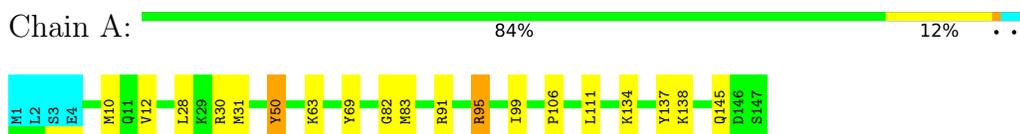
### 4.2.16 Score per residue for model 16

- Molecule 1: Copper-transporting P-type ATPase copA



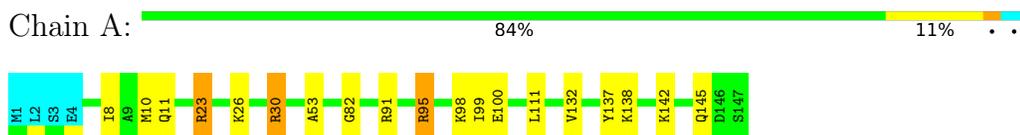
### 4.2.17 Score per residue for model 17

- Molecule 1: Copper-transporting P-type ATPase copA



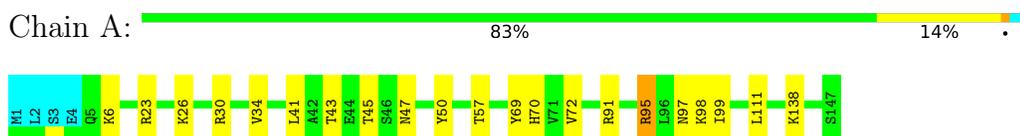
#### 4.2.18 Score per residue for model 18

- Molecule 1: Copper-transporting P-type ATPase copA



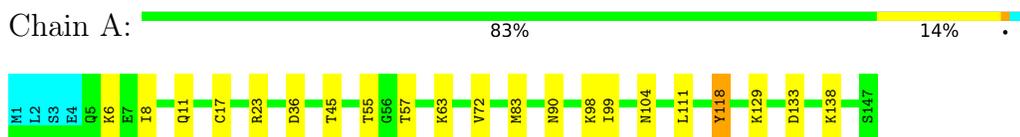
#### 4.2.19 Score per residue for model 19

- Molecule 1: Copper-transporting P-type ATPase copA



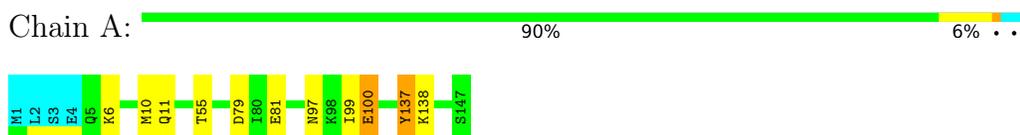
#### 4.2.20 Score per residue for model 20

- Molecule 1: Copper-transporting P-type ATPase copA



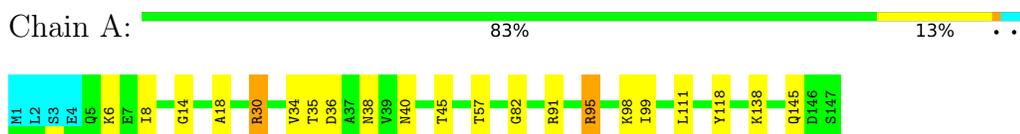
#### 4.2.21 Score per residue for model 21

- Molecule 1: Copper-transporting P-type ATPase copA



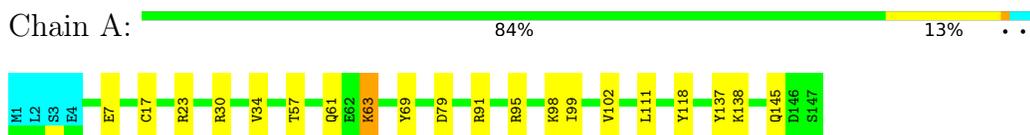
#### 4.2.22 Score per residue for model 22

- Molecule 1: Copper-transporting P-type ATPase copA



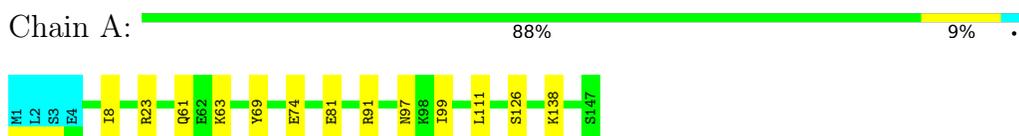
### 4.2.23 Score per residue for model 23

- Molecule 1: Copper-transporting P-type ATPase copA



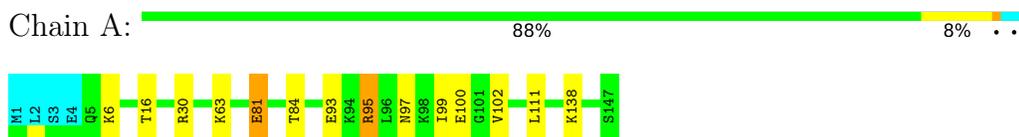
### 4.2.24 Score per residue for model 24

- Molecule 1: Copper-transporting P-type ATPase copA



### 4.2.25 Score per residue for model 25 (medoid)

- Molecule 1: Copper-transporting P-type ATPase copA



## 5 Refinement protocol and experimental data overview

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

Of the 300 calculated structures, 25 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	
DYANA	refinement	

No chemical shift data was provided.

## 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	0.63±0.01	0±0/1088 ( 0.0± 0.0%)	1.04±0.02	3±1/1465 ( 0.2± 0.1%)
All	All	0.63	0/27200 ( 0.0%)	1.04	71/36625 ( 0.2%)

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	1.0±1.0
All	All	0	26

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	30	ARG	NE-CZ-NH1	11.00	125.80	120.30	6	14
1	A	23	ARG	NE-CZ-NH1	9.59	125.09	120.30	9	14
1	A	95	ARG	NE-CZ-NH1	8.65	124.62	120.30	4	16
1	A	91	ARG	NE-CZ-NH1	8.53	124.56	120.30	9	15
1	A	137	TYR	CB-CG-CD2	-7.56	116.47	121.00	3	5
1	A	30	ARG	NE-CZ-NH2	-6.22	117.19	120.30	14	2
1	A	137	TYR	CB-CG-CD1	5.86	124.51	121.00	3	1
1	A	118	TYR	CB-CG-CD2	-5.42	117.75	121.00	20	1
1	A	95	ARG	NE-CZ-NH2	-5.28	117.66	120.30	1	1
1	A	30	ARG	CD-NE-CZ	5.15	130.81	123.60	6	1
1	A	50	TYR	CB-CG-CD2	-5.10	117.94	121.00	17	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	69	TYR	Sidechain,Peptide	6
1	A	99	ILE	Peptide	6
1	A	50	TYR	Sidechain	2
1	A	137	TYR	Sidechain,Peptide	2
1	A	108	ASN	Peptide	1
1	A	146	ASP	Peptide	1
1	A	23	ARG	Sidechain	1
1	A	33	GLY	Peptide	1
1	A	100	GLU	Peptide	1
1	A	43	THR	Peptide	1
1	A	68	GLY	Peptide	1
1	A	12	VAL	Peptide	1
1	A	91	ARG	Sidechain	1
1	A	118	TYR	Sidechain	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	1078	1091	1091	0±1
All	All	26950	27275	27275	9

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 0.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:80:ILE:HD11	1:A:114:VAL:HG12	0.61	1.71	14	2
1:A:99:ILE:HG22	1:A:100:GLU:H	0.54	1.63	18	2
1:A:99:ILE:H	1:A:102:VAL:CG2	0.45	2.24	25	2
1:A:63:LYS:HA	1:A:63:LYS:HE3	0.42	1.92	23	1
1:A:132:VAL:HG13	1:A:137:TYR:CE1	0.41	2.50	18	1
1:A:66:LYS:HA	1:A:66:LYS:HE3	0.40	1.94	8	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	142/147 (97%)	125±3 (88±2%)	14±3 (10±2%)	4±2 (3±1%)	8	44
All	All	3550/3675 (97%)	3116 (88%)	343 (10%)	91 (3%)	8	44

All 25 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	99	ILE	18
1	A	145	GLN	11
1	A	82	GLY	8
1	A	17	CYS	6
1	A	81	GLU	5
1	A	71	VAL	5
1	A	72	VAL	5
1	A	53	ALA	4
1	A	44	GLU	3
1	A	32	PRO	3
1	A	100	GLU	3
1	A	84	THR	3
1	A	18	ALA	2
1	A	108	ASN	2
1	A	109	PHE	2
1	A	98	LYS	2
1	A	12	VAL	1
1	A	43	THR	1
1	A	42	ALA	1
1	A	55	THR	1
1	A	102	VAL	1
1	A	41	LEU	1
1	A	97	ASN	1
1	A	106	PRO	1
1	A	14	GLY	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	115/119 (97%)	103±2 (90±2%)	12±2 (10±2%)	11	56
All	All	2875/2975 (97%)	2586 (90%)	289 (10%)	11	56

All 72 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	138	LYS	25
1	A	111	LEU	21
1	A	63	LYS	15
1	A	11	GLN	12
1	A	6	LYS	11
1	A	83	MET	11
1	A	95	ARG	11
1	A	118	TYR	8
1	A	97	ASN	7
1	A	34	VAL	7
1	A	30	ARG	7
1	A	26	LYS	6
1	A	36	ASP	6
1	A	69	TYR	6
1	A	8	ILE	6
1	A	7	GLU	5
1	A	57	THR	5
1	A	66	LYS	5
1	A	16	THR	4
1	A	23	ARG	4
1	A	79	ASP	4
1	A	129	LYS	4
1	A	133	ASP	4
1	A	35	THR	4
1	A	45	THR	4
1	A	61	GLN	4
1	A	98	LYS	4
1	A	31	MET	3
1	A	40	ASN	3

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Mol	Chain	Res	Type	Models (Total)
1	A	104	ASN	3
1	A	134	LYS	3
1	A	43	THR	3
1	A	100	GLU	3
1	A	50	TYR	3
1	A	55	THR	3
1	A	81	GLU	3
1	A	137	TYR	3
1	A	10	MET	3
1	A	145	GLN	2
1	A	127	ASP	2
1	A	119	ASN	2
1	A	74	GLU	2
1	A	75	LYS	2
1	A	142	LYS	2
1	A	41	LEU	2
1	A	54	GLU	2
1	A	109	PHE	2
1	A	80	ILE	2
1	A	51	ASP	2
1	A	126	SER	2
1	A	72	VAL	1
1	A	113	THR	1
1	A	94	LYS	1
1	A	85	CYS	1
1	A	139	LEU	1
1	A	121	LYS	1
1	A	122	GLU	1
1	A	125	VAL	1
1	A	71	VAL	1
1	A	12	VAL	1
1	A	91	ARG	1
1	A	146	ASP	1
1	A	141	LEU	1
1	A	102	VAL	1
1	A	140	LYS	1
1	A	147	SER	1
1	A	28	LEU	1
1	A	47	ASN	1
1	A	70	HIS	1
1	A	90	ASN	1
1	A	38	ASN	1

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Mol	Chain	Res	Type	Models (Total)
1	A	93	GLU	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

No chemical shift data were provided