



Full wwPDB NMR Structure Validation Report ⓘ

Feb 13, 2017 – 12:51 am GMT

PDB ID : 2MA3
Title : NMR solution structure of the C-terminus of the minichromosome maintenance protein MCM from *Methanothermobacter thermautotrophicus*
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Deposited on : 2013-06-26

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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
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)
RCI : v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV : Wang et al. (2010)
ShiftChecker : trunk28760
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : recalc28949

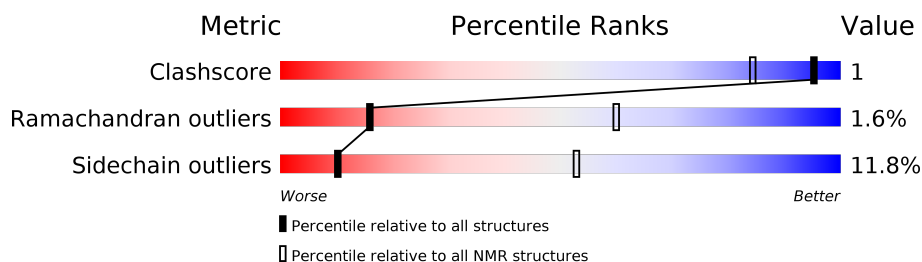
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment is 90%.

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	125131	11601
Ramachandran outliers	121729	10391
Sidechain outliers	121581	10367

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 $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	88	

2 Ensemble composition and analysis

This entry contains 20 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:601-A:666 (66)	0.25	1

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. No single-model clusters were found.

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

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 1439 atoms, of which 729 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called DNA replication initiator (Cdc21/Cdc54).

Mol	Chain	Residues	Atoms						Trace
1	A	88	Total	C	H	N	O	S	0
			1439	448	729	120	139	3	

There are 4 discrepancies between the modelled and reference sequences:

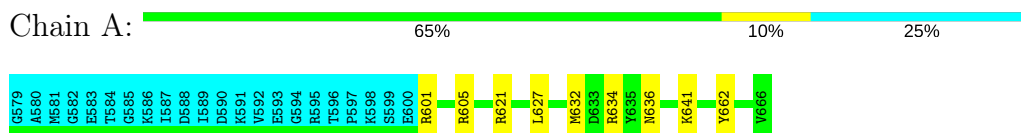
Chain	Residue	Modelled	Actual	Comment	Reference
A	579	GLY	-	EXPRESSION TAG	UNP O27798
A	580	ALA	-	EXPRESSION TAG	UNP O27798
A	581	MET	-	EXPRESSION TAG	UNP O27798
A	582	GLY	-	EXPRESSION TAG	UNP O27798

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: DNA replication initiator (Cdc21/Cdc54)

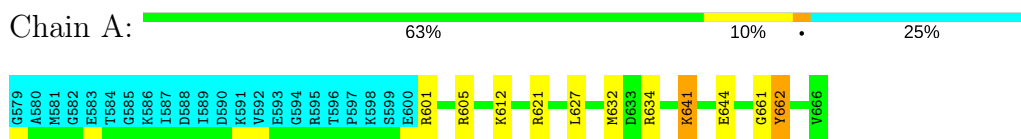


4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

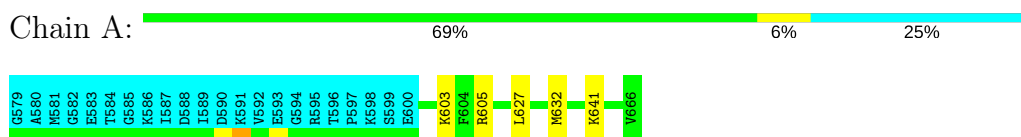
4.2.1 Score per residue for model 1 (medoid)

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



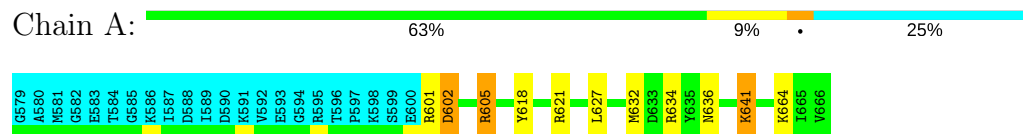
4.2.2 Score per residue for model 2

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



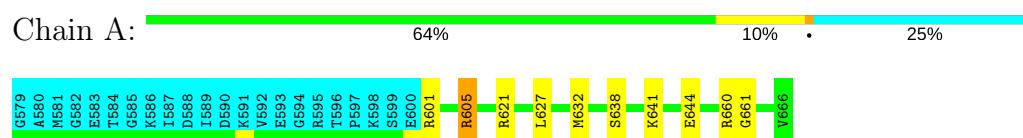
4.2.3 Score per residue for model 3

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



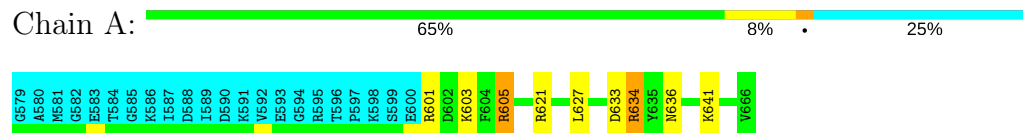
4.2.4 Score per residue for model 4

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



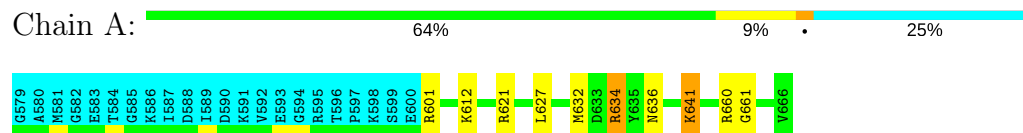
4.2.5 Score per residue for model 5

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



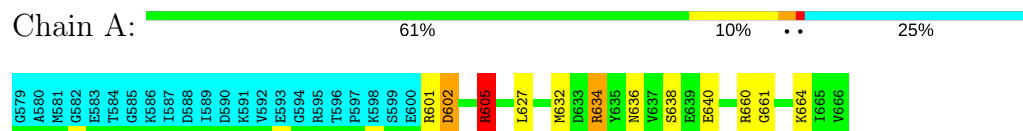
4.2.6 Score per residue for model 6

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



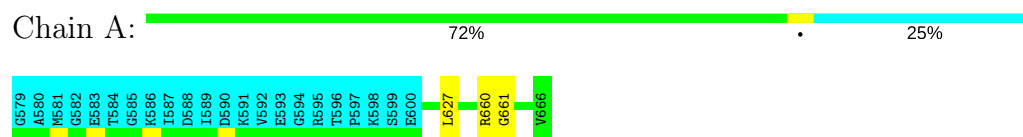
4.2.7 Score per residue for model 7

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



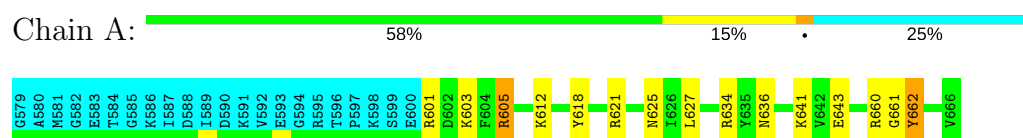
4.2.8 Score per residue for model 8

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



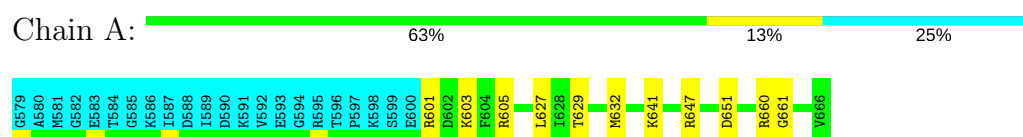
4.2.9 Score per residue for model 9

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



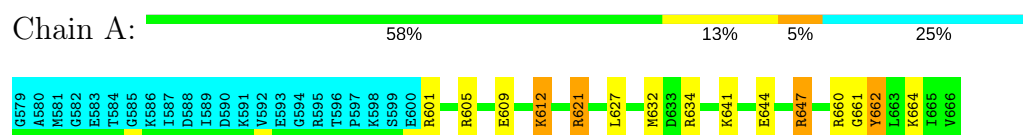
4.2.10 Score per residue for model 10

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



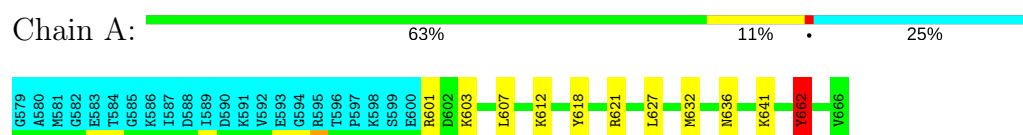
4.2.11 Score per residue for model 11

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



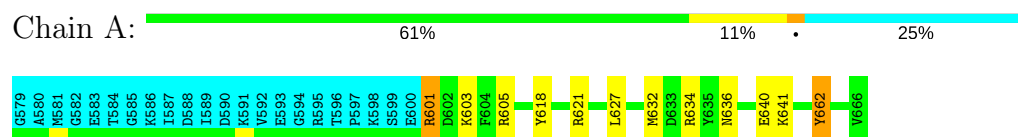
4.2.12 Score per residue for model 12

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



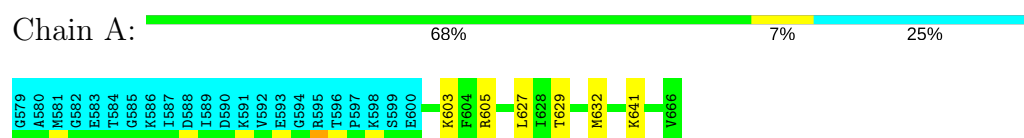
4.2.13 Score per residue for model 13

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



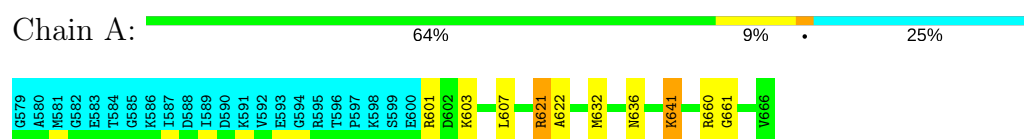
4.2.14 Score per residue for model 14

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



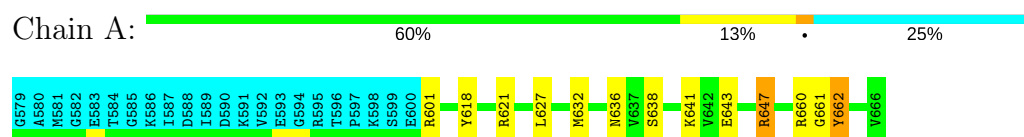
4.2.15 Score per residue for model 15

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



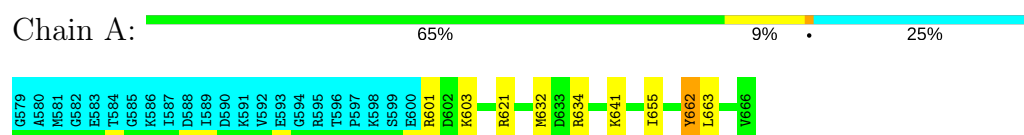
4.2.16 Score per residue for model 16

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



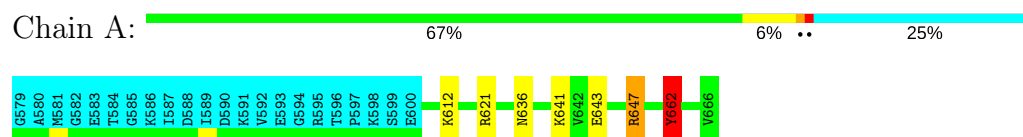
4.2.17 Score per residue for model 17

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



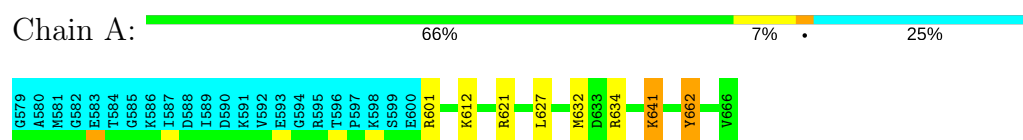
4.2.18 Score per residue for model 18

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



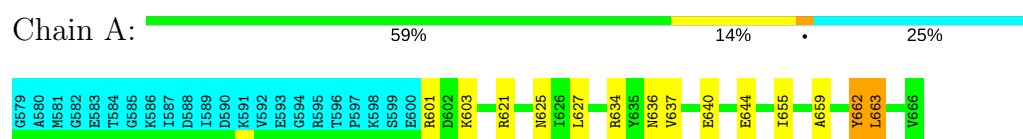
4.2.19 Score per residue for model 19

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



4.2.20 Score per residue for model 20

- Molecule 1: DNA replication initiator (Cdc21/Cdc54)



5 Refinement protocol and experimental data overview

The models were refined using the following method: *DGSA-distance geometry 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
CYANA	structure solution	
CYANA	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)	2ma3_cs.str
Number of chemical shift lists	1
Total number of shifts	1133
Number of shifts mapped to atoms	1133
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	90%

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

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	0.64±0.01	0±0/557 (0.0±0.0%)	1.04±0.04	2±1/744 (0.2±0.2%)
All	All	0.64	0/11140 (0.0%)	1.04	30/14880 (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	0.8±0.6
All	All	0	16

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	634	ARG	NE-CZ-NH1	10.76	125.68	120.30	1	5
1	A	634	ARG	NE-CZ-NH2	-9.56	115.52	120.30	1	2
1	A	605	ARG	NE-CZ-NH2	-9.00	115.80	120.30	9	4
1	A	601	ARG	NE-CZ-NH2	-7.34	116.63	120.30	1	5
1	A	605	ARG	NE-CZ-NH1	7.12	123.86	120.30	3	3
1	A	647	ARG	NE-CZ-NH2	6.50	123.55	120.30	11	3
1	A	634	ARG	CD-NE-CZ	6.49	132.68	123.60	5	2
1	A	601	ARG	NE-CZ-NH1	6.28	123.44	120.30	6	2
1	A	602	ASP	CB-CG-OD2	-5.93	112.96	118.30	3	2
1	A	662	TYR	CB-CG-CD2	-5.85	117.49	121.00	12	1
1	A	662	TYR	CA-CB-CG	5.20	123.28	113.40	12	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	634	ARG	Sidechain	7
1	A	605	ARG	Sidechain	4
1	A	601	ARG	Sidechain	2
1	A	621	ARG	Sidechain	2
1	A	662	TYR	Sidechain	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	550	566	566	1±1
All	All	11000	11320	11320	27

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:603:LYS:HE3	1:A:637:VAL:HG22	0.57	1.74	20	1
1:A:641:LYS:HA	1:A:641:LYS:HE3	0.57	1.75	15	1
1:A:641:LYS:HE3	1:A:641:LYS:HA	0.54	1.77	3	2
1:A:655:ILE:HD12	1:A:663:LEU:HD23	0.49	1.84	20	1
1:A:602:ASP:HB3	1:A:605:ARG:HD3	0.48	1.85	3	2
1:A:621:ARG:HA	1:A:662:TYR:CE1	0.48	2.43	17	10
1:A:655:ILE:HD12	1:A:663:LEU:HD22	0.45	1.89	17	1
1:A:602:ASP:HB3	1:A:605:ARG:CD	0.42	2.44	3	1
1:A:602:ASP:CB	1:A:605:ARG:HD3	0.42	2.45	3	1
1:A:609:GLU:HA	1:A:612:LYS:HE3	0.41	1.92	11	1
1:A:659:ALA:HB3	1:A:662:TYR:HB3	0.41	1.93	20	1
1:A:641:LYS:CA	1:A:641:LYS:HE2	0.41	2.45	1	2
1:A:603:LYS:CE	1:A:637:VAL:HG22	0.41	2.44	20	1
1:A:655:ILE:HD12	1:A:663:LEU:CD2	0.41	2.46	20	1
1:A:640:GLU:OE1	1:A:641:LYS:HE3	0.40	2.16	13	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	65/88 (74%)	61±1 (95±2%)	3±1 (4±2%)	1±1 (2±1%)	16	60
All	All	1300/1760 (74%)	1229 (95%)	50 (4%)	21 (2%)	16	60

All 4 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	661	GLY	10
1	A	660	ARG	8
1	A	636	ASN	2
1	A	622	ALA	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	59/76 (78%)	52±2 (88±4%)	7±2 (12±4%)	10	53
All	All	1180/1520 (78%)	1041 (88%)	139 (12%)	10	53

All 25 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	627	LEU	17
1	A	641	LYS	16
1	A	632	MET	15
1	A	601	ARG	10
1	A	662	TYR	10
1	A	603	LYS	9

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Mol	Chain	Res	Type	Models (Total)
1	A	636	ASN	9
1	A	612	LYS	7
1	A	605	ARG	6
1	A	618	TYR	5
1	A	621	ARG	5
1	A	644	GLU	4
1	A	647	ARG	4
1	A	664	LYS	3
1	A	643	GLU	3
1	A	638	SER	3
1	A	629	THR	2
1	A	607	LEU	2
1	A	640	GLU	2
1	A	625	ASN	2
1	A	633	ASP	1
1	A	663	LEU	1
1	A	634	ARG	1
1	A	651	ASP	1
1	A	660	ARG	1

6.3.3 RNA ⓘ

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

6.6 Ligand geometry ⓘ

There are no ligands in this entry.

6.7 Other polymers ⓘ

There are no such molecules in this entry.

6.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

7 Chemical shift validation

The completeness of assignment taking into account all chemical shift lists is 90% for the well-defined parts and 90% for the entire structure.

7.1 Chemical shift list 1

File name: 2ma3_cs.str

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	1133
Number of shifts mapped to atoms	1133
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

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction \pm precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	87	-0.30 ± 0.18	None needed (< 0.5 ppm)
$^{13}\text{C}_\beta$	80	0.16 ± 0.17	None needed (< 0.5 ppm)
$^{13}\text{C}'$	86	-0.48 ± 0.11	None needed (< 0.5 ppm)
^{15}N	83	0.60 ± 0.17	Should be applied

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 90%, i.e. 793 atoms were assigned a chemical shift out of a possible 881. 0 out of 11 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^1H	^{13}C	^{15}N
Backbone	326/326 (100%)	130/130 (100%)	132/132 (100%)	64/64 (100%)
Sidechain	419/505 (83%)	259/295 (88%)	160/184 (87%)	0/26 (0%)

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	Total	¹ H	¹³ C	¹⁵ N
Aromatic	48/50 (96%)	24/26 (92%)	24/24 (100%)	0/0 (—%)
Overall	793/881 (90%)	413/451 (92%)	316/340 (93%)	64/90 (71%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 90%, i.e. 1012 atoms were assigned a chemical shift out of a possible 1129. 0 out of 12 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	¹ H	¹³ C	¹⁵ N
Backbone	426/434 (98%)	170/173 (98%)	173/176 (98%)	83/85 (98%)
Sidechain	538/645 (83%)	334/377 (89%)	204/236 (86%)	0/32 (0%)
Aromatic	48/50 (96%)	24/26 (92%)	24/24 (100%)	0/0 (—%)
Overall	1012/1129 (90%)	528/576 (92%)	401/436 (92%)	83/117 (71%)

7.1.4 Statistically unusual chemical shifts ⓘ

There are no statistically unusual chemical shifts.

7.1.5 Random Coil Index (RCI) plots ⓘ

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:

