Full wwPDB NMR Structure Validation Report (i)

Apr 27, 2016 – 03:38 AM BST

PDB ID	:	2MQO
Title	:	Structural Investigation of hnRNP L bound to RNA
Authors	:	Blatter, M.; Allain, F.
Deposited on	:	2014-06-24

This is a Full wwPDB NMR Structure Validation Report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
http://wwpdb.org/validation/2016/NMRValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The following versions of software and data (see references (i)) were used in the production of this report:

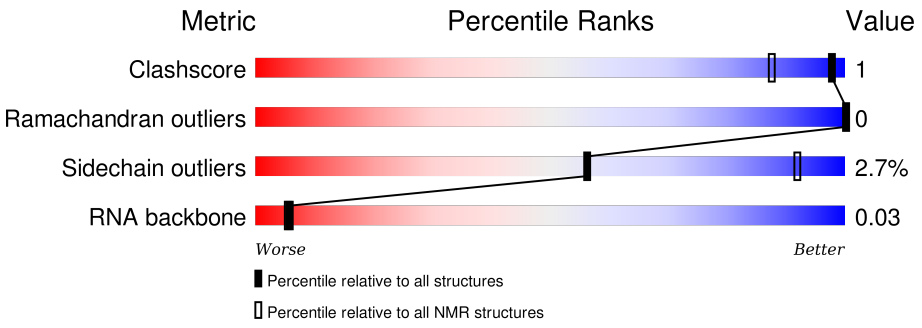
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal 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 (i)

The following experimental techniques were used to determine the structure:
SOLUTION NMR

The overall completeness of chemical shifts assignment is 81%.

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
RNA backbone	3027	600

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 <=5%

Mol	Chain	Length	Quality of chain
1	A	105	75% • 24%
2	B	6	17% 50% 33%

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 6 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:95-A:174 (80)	0.14	6

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 2 single-model clusters were found.

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

3 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 1760 atoms, of which 836 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Protein Hnrnpl.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	105	1571	501	770	137	161	2	0

- Molecule 2 is a RNA chain called RNA (5'-R(*CP*AP*CP*AP*CP*A)-3').

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	P	
2	B	6	189	57	66	24	37	5	0

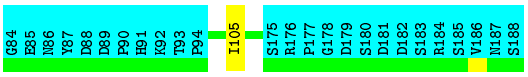
4 Residue-property plots (i)

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.

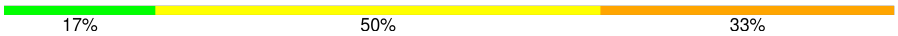
- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:



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: Protein Hnrnpl

Chain A:

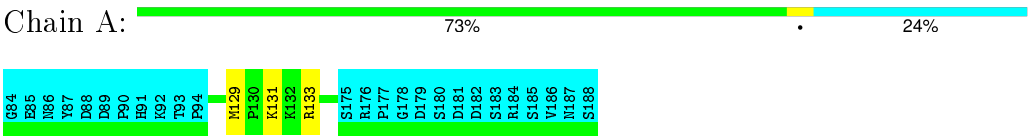
- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:

4.2.2 Score per residue for model 2

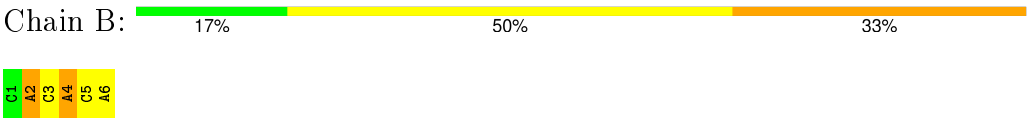
- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

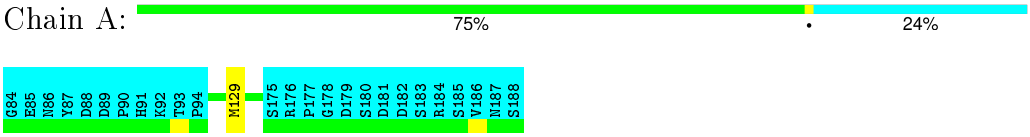
Chain B:



4.2.3 Score per residue for model 3

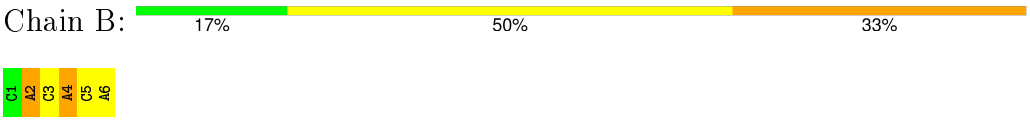
- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

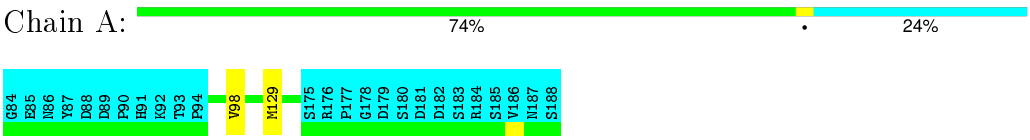
Chain B:



4.2.4 Score per residue for model 4

- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:

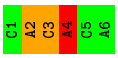
4.2.5 Score per residue for model 5

- Molecule 1: Protein Hnrnpl

Chain A: 74% • 24%

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B: 50% 33% 17%



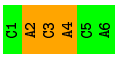
4.2.6 Score per residue for model 6 (medoid)

- Molecule 1: Protein Hnrnpl

Chain A: 75% • 24%

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

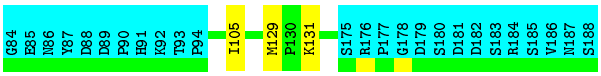
Chain B: 50% 50%



4.2.7 Score per residue for model 7

- Molecule 1: Protein Hnrnpl

Chain A: 73% • 24%



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B: 17% 33% 33% 17%

4.2.8 Score per residue for model 8

- Molecule 1: Protein Hnrnpl

Chain A: 74% • 24%

G84 E85 N86 Y87 D88 D89 P90 H91 K92 T93 P94 M129 T170 S175 R176 P177 G178 D179 S180 D181 D182 S183 R184 S185 V186 N187 S188

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B: 17% 50% 33%

C1 A2 C3 A4 C5 A6

4.2.9 Score per residue for model 9

- Molecule 1: Protein Hnrnpl

Chain A: 74% • 24%

G84 E85 N86 Y87 D88 D89 P90 H91 K92 T93 P94 I105 T170 S175 R176 P177 G178 D179 S180 D181 D182 S183 R184 S185 V186 N187 S188

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B: 33% 33% 17% 17%

C1 A2 C3 A4 C5 A6

4.2.10 Score per residue for model 10

- Molecule 1: Protein Hnrnpl

Chain A: 75% • 24%

G84 E85 N86 Y87 D88 D89 P90 H91 K92 T93 P94 T170 S175 R176 P177 G178 D179 S180 D181 D182 S183 R184 S185 V186 N187 S188

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

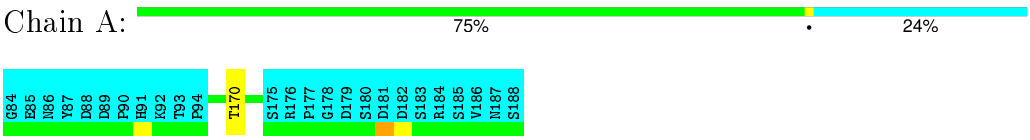
Chain B: 17% 50% 33%

C1 A2 C3 A4 C5 A6

4.2.11 Score per residue for model 11

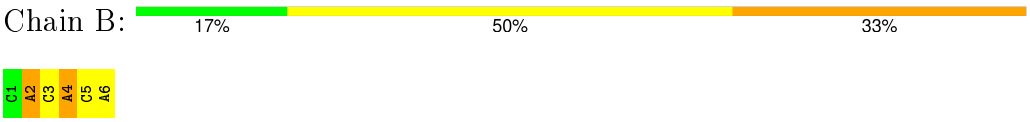
- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

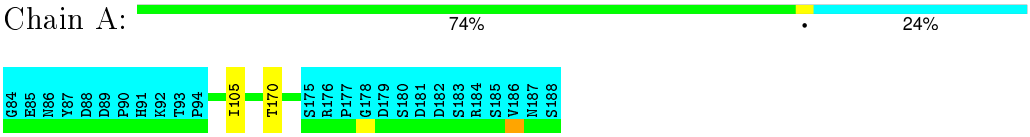
Chain B:



4.2.12 Score per residue for model 12

- Molecule 1: Protein Hnrnpl

Chain A:



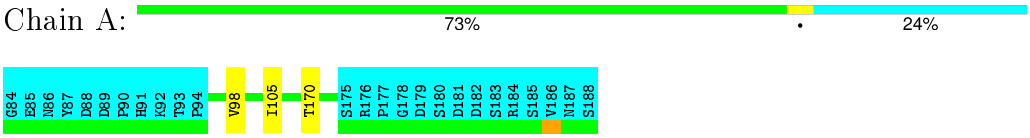
- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:

4.2.13 Score per residue for model 13

- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:

4.2.14 Score per residue for model 14

- Molecule 1: Protein Hnrnpl

Chain A: 76% 24%

G84 E85 N86 Y87 D88 D89 P90 H91 K92 T93 P94 S175 R176 P177 G178 D179 S180 D181 D182 S183 R184 S185 V186 N187 S188

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B: 33% 33% 33%

C1 A2 C3 A4 C5 A6

4.2.15 Score per residue for model 15

- Molecule 1: Protein Hnrnpl

Chain A: 75% • 24%

G84 E85 N86 Y87 D88 D89 P90 H91 K92 T93 P94 K131 S175 R176 P177 G178 D179 S180 D181 D182 S183 R184 S185 V186 N187 S188

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B: 17% 50% 33%

C1 A2 C3 A4 C5 A6

4.2.16 Score per residue for model 16

- Molecule 1: Protein Hnrnpl

Chain A: 74% • 24%

G84 E85 N86 Y87 D88 D89 P90 H91 K92 T93 P94 I105 M129 S175 R176 P177 G178 D179 S180 D181 D182 S183 R184 S185 V186 N187 S188

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

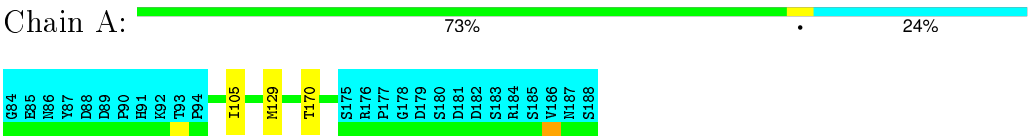
Chain B: 33% 50% 17%

C1 A2 C3 A4 C5 A6

4.2.17 Score per residue for model 17

- Molecule 1: Protein Hnrnpl

Chain A:



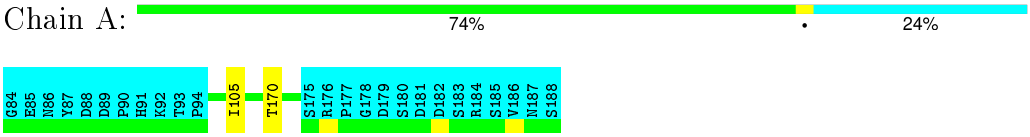
- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:

4.2.18 Score per residue for model 18

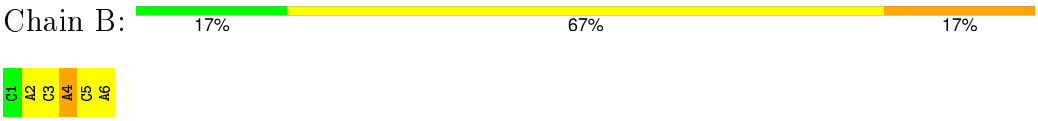
- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

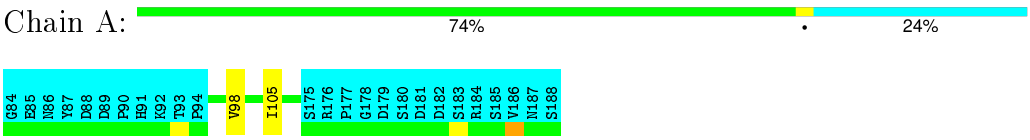
Chain B:



4.2.19 Score per residue for model 19

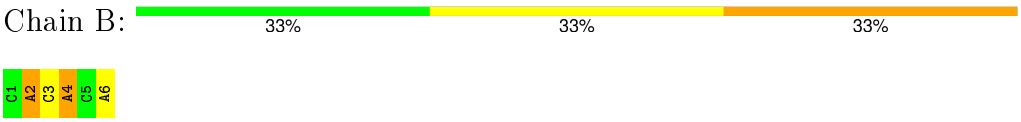
- Molecule 1: Protein Hnrnpl

Chain A:



- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:



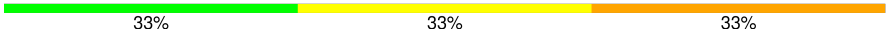
4.2.20 Score per residue for model 20

- Molecule 1: Protein Hnrnpl

Chain A:

- Molecule 2: RNA (5'-R(*CP*AP*CP*AP*CP*A)-3')

Chain B:



5 Refinement protocol and experimental data overview (i)

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

Of the 250 calculated structures, 20 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	
AMBER	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)	2mqo_cs.str
Number of chemical shift lists	2
Total number of shifts	1200
Number of shifts mapped to atoms	1200
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	81%

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	0.50±0.00	0±0/623 (0.0±0.0%)	0.69±0.01	0±0/851 (0.0±0.0%)
2	B	0.99±0.01	0±0/137 (0.0±0.0%)	1.51±0.02	1±1/211 (0.6±0.4%)
All	All	0.62	0/15200 (0.0%)	0.92	25/21240 (0.1%)

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(^{o})	Ideal(^{o})	Models	
								Worst	Total
2	B	2	A	O4'-C1'-N9	7.56	114.25	108.20	12	18
2	B	3	C	O4'-C1'-N1	5.36	112.49	108.20	13	2
2	B	5	C	O4'-C1'-N1	5.18	112.35	108.20	7	1
2	B	4	A	O4'-C1'-N9	5.15	112.32	108.20	9	2
2	B	4	A	C5'-C4'-C3'	-5.09	107.85	116.00	7	1
2	B	3	C	C5'-C4'-C3'	-5.04	107.94	116.00	6	1

There are no chirality outliers.

There are no planarity outliers.

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	610	607	607	0±0
2	B	123	66	68	1±0
All	All	14660	13460	13500	20

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
2:B:4:A:H5"	2:B:4:A:C8	0.53	2.39	5	9
2:B:4:A:C8	2:B:4:A:H5"	0.52	2.40	1	11

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	80/105 (76%)	79±1 (99±1%)	1±1 (1±1%)	0±0 (0±0%)	100	100
All	All	1600/2100 (76%)	1584 (99%)	16 (1%)	0 (0%)	100	100

There are no Ramachandran outliers.

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	65/88 (74%)	63±1 (97±1%)	2±1 (3±1%)	56	92
All	All	1300/1760 (74%)	1265 (97%)	35 (3%)	56	92

All 6 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	105	ILE	12
1	A	170	THR	9

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Mol	Chain	Res	Type	Models (Total)
1	A	129	MET	7
1	A	131	LYS	3
1	A	98	VAL	3
1	A	133	ARG	1

6.3.3 RNA (i)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers	Suiteness
2	B	5/6 (83%)	4±1 (85±17%)	1±1 (28±12%)	0.03±0.04
All	All	100/120 (83%)	85 (85%)	28 (28%)	0.03

The overall RNA backbone suiteness is 0.03.

All unique RNA backbone outliers are listed below:

Mol	Chain	Res	Type	Models (Total)
2	B	4	A	20
2	B	3	C	20
2	B	2	A	20
2	B	6	A	14
2	B	5	C	11

All unique RNA pucker outliers are listed below:

Mol	Chain	Res	Type	Models (Total)
2	B	4	A	20
2	B	2	A	7
2	B	5	C	1

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 81% for the well-defined parts and 80% for the entire structure.

7.1 Chemical shift list 1

File name: 2mqo_cs.str

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	1110
Number of shifts mapped to atoms	1110
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	1

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	96	-0.16 ± 0.09	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	97	-0.13 ± 0.28	None needed (< 0.5 ppm)
$^{13}C'$	0	—	—
^{15}N	94	0.65 ± 0.29	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 73%, i.e. 769 atoms were assigned a chemical shift out of a possible 1054. 17 out of 17 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	298/392 (76%)	149/156 (96%)	74/160 (46%)	75/76 (99%)
Sidechain	418/475 (88%)	252/274 (92%)	160/184 (87%)	6/17 (35%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	53/73 (73%)	35/39 (90%)	18/32 (56%)	0/2 (0%)
Overall	769/1054 (73%)	436/535 (81%)	252/418 (60%)	81/101 (80%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 73%, i.e. 976 atoms were assigned a chemical shift out of a possible 1336. 18 out of 18 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	380/511 (74%)	190/203 (94%)	96/210 (46%)	94/98 (96%)
Sidechain	533/623 (86%)	327/363 (90%)	198/234 (85%)	8/26 (31%)
Aromatic	63/88 (72%)	41/47 (87%)	22/38 (58%)	0/3 (0%)
Overall	976/1336 (73%)	558/679 (82%)	316/524 (60%)	102/133 (77%)

7.1.4 Statistically unusual chemical shifts (i)

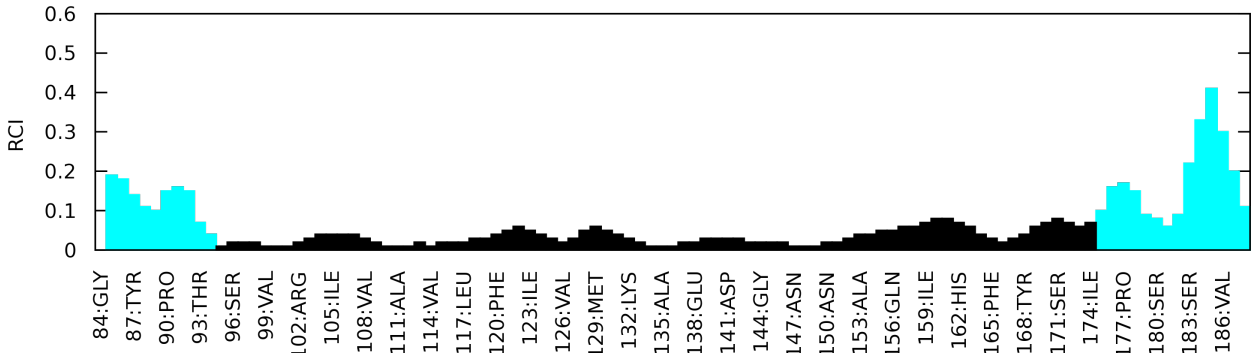
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, *ppm*	Expected range, *ppm*	Z-score
1	A	95	ALA	HA	1.89	6.46 – 2.06	-5.4

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:



7.2 Chemical shift list 2

File name: 2mqo_cs.str

Chemical shift list name: *shifts2*

7.2.1 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	90
Number of shifts mapped to atoms	90
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

7.2.2 Chemical shift referencing (i)

No chemical shift referencing corrections were calculated (not enough data).

7.2.3 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 9%, i.e. 90 atoms were assigned a chemical shift out of a possible 1054. 0 out of 17 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}**H**	^{13}**C**	^{15}**N**
Backbone	0/392 (0%)	0/156 (0%)	0/160 (0%)	0/76 (0%)
Sidechain	0/475 (0%)	0/274 (0%)	0/184 (0%)	0/17 (0%)
Aromatic	0/73 (0%)	0/39 (0%)	0/32 (0%)	0/2 (0%)
Overall	90/1054 (9%)	48/535 (9%)	42/418 (10%)	0/101 (0%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 7%, i.e. 90 atoms were assigned a chemical shift out of a possible 1336. 0 out of 18 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}**H**	^{13}**C**	^{15}**N**
Backbone	0/511 (0%)	0/203 (0%)	0/210 (0%)	0/98 (0%)
Sidechain	0/623 (0%)	0/363 (0%)	0/234 (0%)	0/26 (0%)
Aromatic	0/88 (0%)	0/47 (0%)	0/38 (0%)	0/3 (0%)
Overall	90/1336 (7%)	48/679 (7%)	42/524 (8%)	0/133 (0%)

7.2.4 Statistically unusual chemical shifts (i)

There are no statistically unusual chemical shifts.

7.2.5 Random Coil Index (RCI) plots (i)

No *random coil index* (RCI) plot could be generated from the current chemical shift list (shifts2). RCI is only applicable to proteins.